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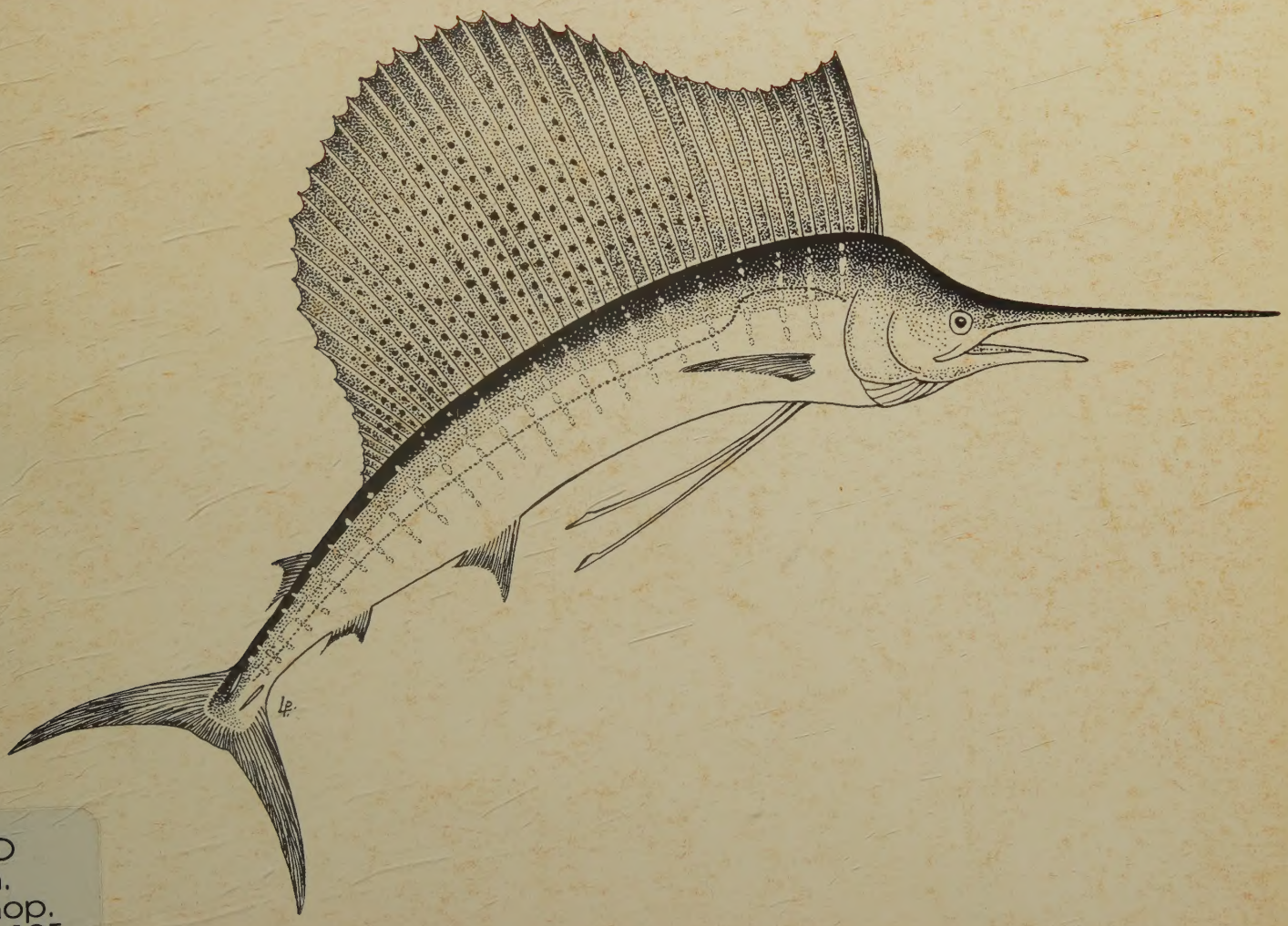
FAO SPECIES CATALOGUE

Vol. 5. BILLFISHES OF THE WORLD

AN ANNOTATED AND ILLUSTRATED CATALOGUE OF MARLINS, SAILFISHES, SPEARFISHES AND SWORDFISHES KNOWN TO DATE



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FAO SPECIES CATALOGUE

VOL. 5 BILLFISHES OF THE WORLD

An Annotated and Illustrated Catalogue of Marlins, Sailfishes, Spearfishes and Swordfishes Known to Date

prepared by

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Prepared with the support from the
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"Then the fish came alive, with his death in him, and rose high out of the water showing all his power and his beauty. He seemed to hang in the air above the old man in the skiff. Then he fell into the water with a crash that sent spray over the old man and over all of the skiff" (from The Old Man and the Sea, by Ernest Hemingway). I do hope for the eternal prosperity of these beautiful and powerful animals in our water planet.

PREPARATION OF THIS DOCUMENT

The present publication was prepared under the FAO Regular Programme with the support of the United Nations Development Programme as part of the UNDP/FAO Global Project on Survey and Identification of the World's Marine Fishery Resources (GLO/82/001). It is the fifth worldwide species catalogue issued under the FAO Fisheries Synopses series.

The author is one of the foremost authorities on billfish taxonomy (see Nakamura, I., 1983) and has also had a long field experience on the biology and fisheries of these species. He has prepared, in the course of the past seven years, all FAO species identification sheets so far published on this group (Western Central Atlantic, Eastern Central Atlantic and Western Indian Ocean).

The index of scientific and vernacular names was prepared in collaboration with FAO's Fishery Information, Data and Statistics Service.

Most illustrations were redrawn from draft material provided by the author.

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ABSTRACT

This is the fifth in the FAO series of worldwide annotated and illustrated catalogues of major groups of organisms that enter marine fisheries. The present volume includes the two families and all 12 species of billfishes known so far. It provides a comprehensive and illustrated key to families and species, with a glossary of technical terms and measurements. Within each family are given individual accounts of species which include drawings, scientific and vernacular names, information on habitat, biology and fisheries, and a distribution map. The section including family and species accounts is followed by a table indicating the distribution of each species by major marine fishing areas. The work is fully indexed and there is ample reference to pertinent literature.

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1. INTRODUCTION

This review covers the 12 species of billfishes recognized to date, even though the taxonomic status of one of them (Tetrapturus georgei) is still somewhat uncertain. A thirteenth form, the so-called "Hatchet marlin", often mentioned in recent literature, is also briefly presented (see page 5), but cannot be recognized as a valid species on the basis of the presently available data.

The systematic part of the present catalogue is based primarily on Nakamura, Iwai and Matsubara (1968), Nakamura (1974) and Nakamura (1983), while the remaining information, particularly that on biology and fisheries of the various species, stems from the author's personal experience and pertinent literature available to him. In order to avoid overcharging the text with literature citations, every effort was made to restrict these to papers considered to be of specific relevance to the biology and fisheries of the species in question. Many other important papers, particularly on systematics, anatomy, distribution and the more general aspects of biology and fisheries, although omitted in the text, have been included in the bibliography. Although great care was paid in evaluating the published and unpublished information used in this review, some misjudgements and incorrect interpretations will undoubtedly have occurred.

For more detailed information on billfish taxonomy, stocks, biology and fisheries, the reader is referred to specialized periodical publications such as the Bulletin of the Far Seas Fisheries Research Laboratory (Shimizu, Japan), the Fishery Bulletin of NMFS, NOAA, US Department of Commerce (Seattle, USA), and the more comprehensive papers on billfish taxonomy and biology, such as the Proceedings of the International Billfish Symposium, Kailua-Kona, Hawaii, 9 to 12 August 1972, edited by R.S. Shomura and F. Williams (NOAA Technical Report NMFS SSRF-675), "The sailfish, the swashbuckler of the open sea", by J.B. Tinsley (1964), "Billfish, marlin, broadbill, sailfish", by C.O. Mather (1976) and "Systematics of the Billfishes (Xiphiidae and Istiophoridae)" by I. Nakamura (1983).

Acknowledgements

The author wishes to convey his deepest appreciation and thanks to Dr Walter Fischer (FAO, Rome) for his initiative, guidance, encouragement and enthusiastic support; to Dr Shiro Chikuni (FAO, Rome) for his critical revision of the fisheries information included in this catalogue; to Mr Paolo Lastrico for his neat work in redrawing the rough sketches presented with the draft manuscript; to Mrs Michèle Kautenberger-Longo (FAO, Rome) for typing of the final manuscript and to Ms Gloria Soave (FAO, Rome) for the revision of the bibliography.

The author also wishes to express his deep gratitude to:

Mr Sho Okano of the Fishermen's Cooperative of Kyoto Prefecture who granted him permission to examine billfishes landed at the Nishi-Maizuru Fish Market; to Captain Yoshio Kurohiji and the crew of the R/V SHUNYO MARU and to Captain Sadamu Tanabe and the crew of the R/V SHOYO MARU for their valuable help during his participation in several longline fisheries research cruises in the Pacific, Indian and Atlantic oceans.

The fishermen and fisheries technicians who have helped the author in the course of his billfish studies and have given him invaluable information on fisheries, behaviour and biology of these fishes, in particular Mr Guillermo M. Adachi (Manzanillo Game Fishing Club, Mexico); Mr Peter Goadby (Game Fishing Association of Australia); Messrs Jack Izatt, John Covacevich, David Hopton, Peter Nielsen and Joe Bethune and Ms Daphnie Nielson (Cairns Game Fishing Club, Australia); Messrs Toshiro Sato, Wataru Ichikawa, Shoji Nakano and Michio Kuroiwa (Japan Marine Fisheries Resources Research Center); Mr Elwood K. Harry (President of the International Game Fish Association); Messrs Shojiro Shimura and Soroku Togo (Fisheries Agency, Government of Japan); Messrs Seki Araki, Ryoichi Shugyo and Tsuneo Okabe (Nishidomari Fishermen's Cooperative, Tsushima, Japan).

The scientists and research institutions who have provided useful information, or accommodation to the author and offered him their facilities during his visits, in particular: the late Dr Hiroshi Nakamura, Dr Shooji Ueyanagi, Dr Shoji Kikawa, the late Mr Hisaya Watanabe, Dr Keiichiro Mori, Dr Hajime Yamanaka, Mr Yasuo Nishikawa, Dr Toshio Shiohama and Mr Ikuo Warashina (formerly Nankai Regional Fisheries Research Laboratory, Kochi now Far Seas Fisheries Research Laboratory, Shimizu, Japan); the late Prof. Kiyomatsu Matsubara and Prof. Tamotsu Iwai (Kyoto University, Kyoto, Japan); Dr Jiro Isa and Mr Akio Tomori (Okinawa Prefectural Fisheries Experimental Laboratory, Okinawa, Japan); Dr John R. Paxton and Dr Frank Talbot (Australian Museum, Sydney, Australia); Dr Julian G. Pepperell, Mr John Matthews and Mr Robert Williams (New South Wales State Fisheries, Sydney, Australia); Dr Robert H. Gibbs, Jr. (US National Museum of Natural History, Washington, D.C., USA); Dr Bruce B. Collette and Dr Daniel Cohen (Systematics Laboratory, NMFS, NOAA, Washington, D.C., USA); Dr W. Eschmeyer and Dr T. Iwamoto (California Academy of Sciences, San Francisco, USA); Dr Robert J. Lavenberg (Los Angeles County Museum, Los Angeles, USA); the late Prof. Carl L. Hubbs and Prof. Richard H. Rosenblatt (Scripps Institution of Oceanography, La Jolla, USA); Mr Withold L. Klawe (Inter-American Tropical Tuna Commission, La Jolla, USA); Prof. C. Richard Robins and Prof. Donald P. de Sylva (University of Miami, Miami, USA); Dr Francis G. Carey (Woods Hole Oceanographic Institution, Woods Hole, USA); Dr William Smith-Vaniz and the late Dr John Böhlke (Academy of Natural Sciences of Philadelphia, Philadelphia, USA); Dr Donn E. Rosen and Dr C.L. Smith (American Museum of Natural History, New York, USA); Dr Peter J.P. Whitehead, Mr Alwyn Wheeler and Mr Oliver Crimmen (British Museum, Natural History, London, UK); Dr Marie-Louise Bauchot and Ms M. Desoutter (Muséum National d'Histoire Naturelle, Paris, France); Dr Alfred Post (Institut für Seefischerei, Hamburg, Germany, Fed.Rep.); Dr Jørgen Nielsen (Universitetets Zoologiske Museum, Copenhagen, Denmark); Dr E.G. Silas (Central Marine Fisheries Research Institute, Cochin, India); the late Dr H.T. Teng (Taiwan Fisheries Research Institute, Keelung, China); Dr Thosaporn Wongratana (Department of Biology, Chulalongkorn University, Bangkok, Thailand).

Finally, the author wishes to heartily acknowledge the technical assistance provided by Mrs Reiko Nakamura.

1.1 Plan of the Catalogue

This catalogue is arranged alphabetically by genera and species. Each of the multispecies genera is introduced with general descriptive remarks, illustrations of diagnostic features, highlights on the biology, and relevance to fisheries. The information pertaining to each species is arranged by paragraphs, as follows: (1) scientific name, (2) synonymy, (3) FAO species names, (4) field marks, (5) diagnostic features, (6) geographical distribution, (7) habitat and biology, (8) size, (9) interest to fisheries, (10) local species names, (11) literature, and (12) remarks.

(1) **Scientific name :** Reference is given to the original description of each species so no confusion will arise as to precise identification.

(2) **Synonymy:** Synonyms and different name combinations are listed (misidentifications and other nomenclatorial problems are discussed under (11) remarks).

(3) **FAO species names :** English, French and Spanish names for each species, to be used primarily within FAO, were selected on the basis of the following criteria: (i) each name must apply to one species only, in a worldwide context; (ii) the name should not lead to confusion with other groups. Wherever possible, the names selected were based on vernacular names (or parts of names) already in existence within the areas where the species is fished. FAO species names are, of course, not intended to replace local species names, but they are considered necessary to overcome the considerable confusion caused by the use of a single name for many different species, or several names for the same species.

(4) **Field marks :** A few obvious field characters of use in field identification extracted from "Diagnostic Features" at various levels.

(5) **Diagnostic features :** Distinctive characters of the species are given as an aid for identification, accompanied by pertinent illustrations. Species identifications should be attempted only after consultation of the illustrated key to genera and species. Reference to FAO Species Identification Sheets is given wherever relevant.

(6) **Geographical distribution :** The entire known geographic range of the species, including areas of seasonal occurrence, is given in the text and shown on a small map. In cases where only scattered records of occurrence are available, interrogation marks have been used to indicate areas of suspected distribution.

(7) **Habitat and biology :** The known depth range of the species, and information on salinity and temperature of its habitat are given where known. Information on biological aspects, such as migrations, spawning seasons and areas, food, predators and longevity is also included.

(8) **Size :** The maximum known, as well as the common body length and weight (if available) are given. Body length is measured from the tip of the lower jaw to the tip of the caudal rays in the middle of the fork of the tail. The all-tackle angling record and length at first maturity are given where known.

(9) **Interest to fisheries :** This paragraph gives an account of the areas where the species is fished and of the nature of the fishery; its importance is either qualitatively estimated or actual figures of annual landings are provided. Data on utilization (fresh, dried, frozen, canned, etc.) are also given where available. Here too, the quality and quantity of the information available vary considerably with the species.

(10) **Local species names:** These are the names used locally for the various species. The present compilation is necessarily incomplete, since only a fraction of the local names used throughout the world is actually published. In many cases, local names are available only for species supporting documented fisheries. Apart from possible omissions due to limitations of literature available, some of the names included may be somewhat artificial (i.e. through transliteration of indigenous words into English). The local species name is preceeded by the name of the country concerned (in capital letters) and, where necessary, by geographical specifications (in lower case). Whenever possible, the language of the transcribed vernacular name is added in parenthesis. When more than one name is used within a country, the official name, if available, is underlined.

(11) **Literature :** This includes references to the most important publications relevant to the species, the emphasis being on biology and fisheries. Additional references are included in the bibliography. In the case of a few uncommon species, only systematic papers are available.

(12) **Remarks :** Important information concerning the species and not fitting in any of the previous paragraphs is given here. For instance, in some cases the scientific name used in the present catalogue, although nomenclaturally correct, is not the best known. Other nomenclatural problems, such as the use of subspecies, are discussed.

1.2 General Remarks on Billfishes

The term "Billfishes" has been widely accepted by both, commercial and sports fishermen as well as scientists, to apply to the large fishes of the families Xiphiidae and Istiophoridae, characterized by the prolongation of the upper jaw, much beyond the lower jaw, into a long rostrum which is flat and swordlike (swordfish) or rounded and spearlike (sailfishes, spearfishes and marlins). Needlefishes, (Belonidae) are also sometimes referred to as billfishes, but they are easily distinguished from the true billfishes by having both jaws prolonged, the dorsal and anal fins both single and similar in size and shape, and the pelvic fins inserted far behind the pectorals.

The billfishes include 12 species arranged in four genera and two families as follows (see also Fig.1):

Phylum Chordata

Superclass Gnathostomata

Class Osteichthyes

Subclass Actinopterygii

Infraclass Teleostei

Division Euteleostei

Superorder Acanthopterygii

Order Perciformes

Suborder Xiphioidei

Family Xiphiidae

Genus Xiphias

Xiphias gladius - Swordfish (worldwide)

Family Istiophoridae

Genus Istiophorus

Istiophorus albicans - Atlantic sailfish (Atlantic)

Istiophorus platypterus - Indo-Pacific sailfish (Indian and Pacific oceans)

Genus Tetrapturus

Tetrapturus albidus - White marlin (Atlantic)

Tetrapturus angustirostris - Shortbill spearfish (Indian and Pacific oceans)

Tetrapturus audax - Striped marlin (Indian and Pacific oceans)

Tetrapturus belone - Mediterranean spearfish (Mediterranean Sea)

Tetrapturus georgei - Roundscale spearfish (Atlantic)

Tetrapturus pfluegeri - Longbill spearfish (Atlantic)

Genus Makaira

Makaira indica - Black marlin (Indian and Pacific oceans)

Makaira mazara - Indo-Pacific blue marlin (Indian and Pacific oceans)

Makaira nigricans - Atlantic blue marlin (Atlantic)

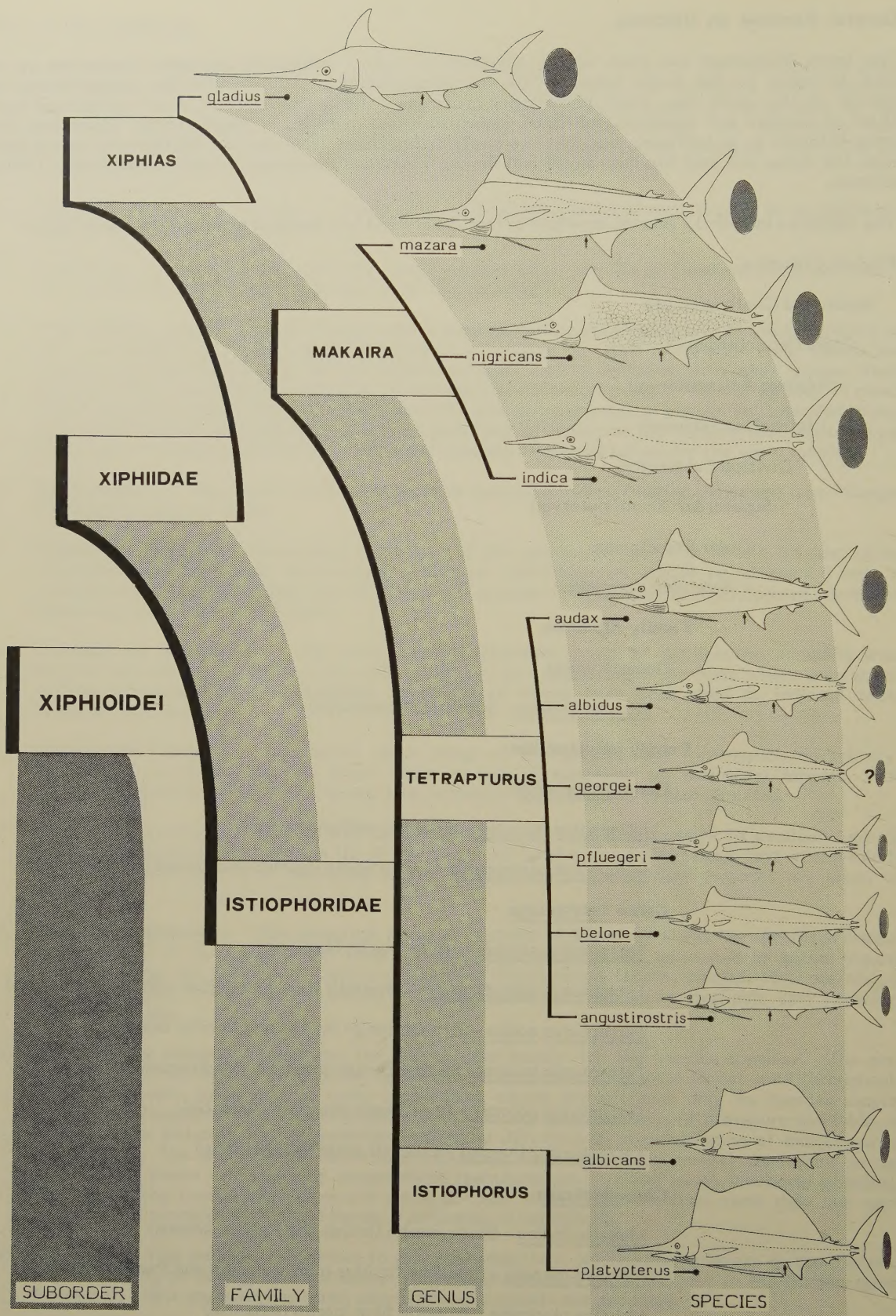
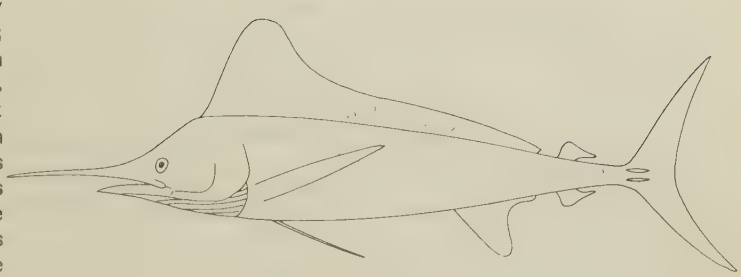


Fig.1 Classification of billfishes

Sizes of drawings correspond roughly to maximum lengths of species; screened oval areas show cross-sections of bodies at level of pectoral fin bases (arrows show position of anus)

Another billfish has recently been reported by several authors (Robins, 1974; de Sylva, 1974; McClane, 1974; Pristas, 1980) from the western Atlantic Ocean, particularly in the Gulf of Mexico. This might be either a new species or an aberrant form of Tetrapturus albidus. Venezuelan and Cuban fishermen have since long referred to this fish as the "Hatchet marlin" or "Axe marlin". It is characterized chiefly by the truncate shape of the anterior lobes of the first dorsal and anal fins (Fig.2). However, in the absence of conclusive taxonomic evidence, a final decision on the status of the Hatchet marlin cannot be made at this time and further study on this problem is urgently needed.



"Hatchet marlin" redrawn from McClane (1974) Fig.2

Xiphias gladius (Family Xiphiidae) differs from all species of the Family Istiophoridae in both external and internal features. Some superficial phenetic similarities, especially between Makaira and Xiphias seem to be due to convergent evolution. As regards the relationship between the three istiophorid genera Tetrapturus, Istiophorus and Makaira, various different opinions have been advanced. Generally, the sailfishes are included in the genus Istiophorus, the small spearfishes in Tetrapturus and the large (blue and black) marlins in Makaira. The smaller marlins (striped and white), have been placed by many authors in either of the genera Tetrapturus and Makaira. On the basis of the present author's recent studies (Nakamura, 1983), it seems clear that these two species, T. albidus and T. audax should be included in the genus Tetrapturus together with the small spearfishes, T. angustirostris, T. belone, T. pfluegeri and T. georgei (Fig.1).

It is likely that enlargement of the body as well as acquirement of the capability for fast swimming have been an evolutionary trend in billfishes (see maximum body sizes of living billfishes in Fig.3).

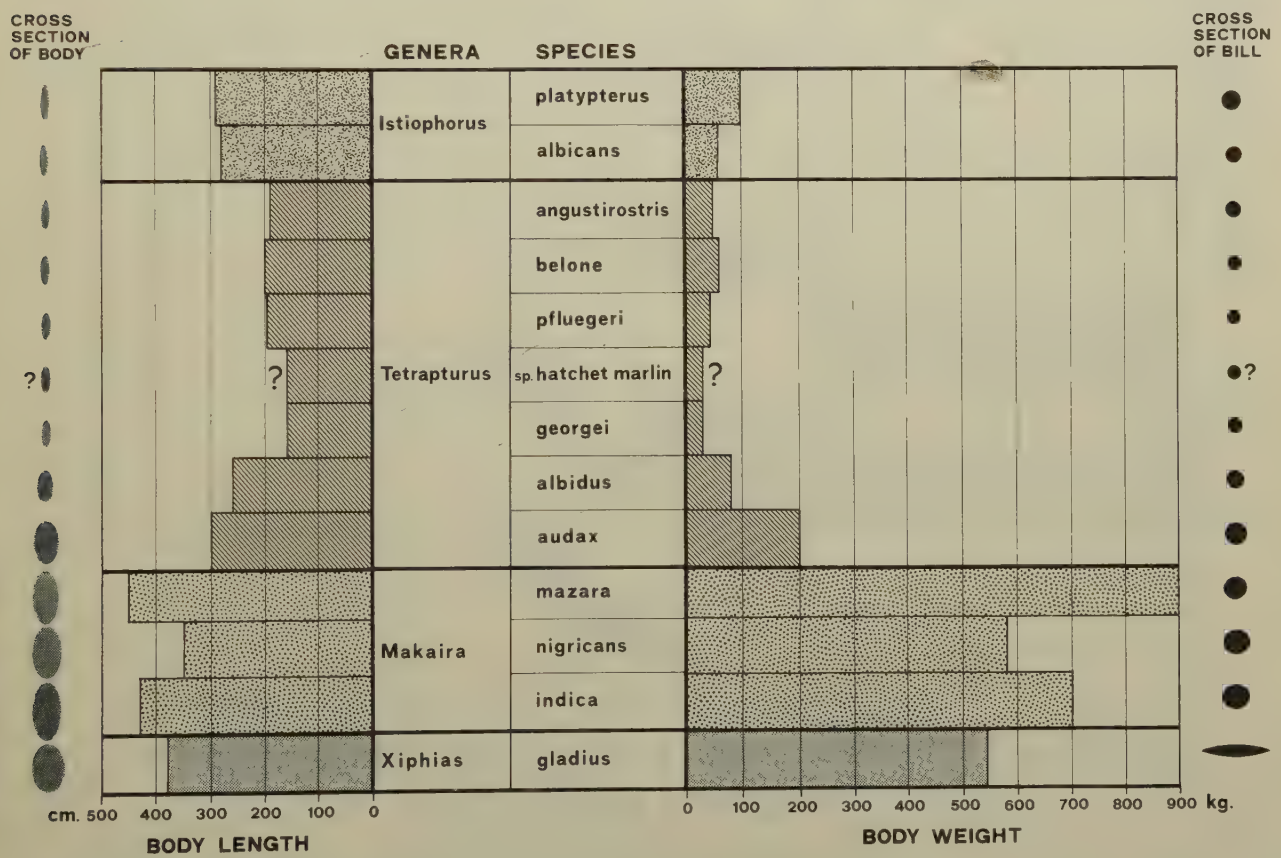


Fig.3 Comparison of approximate maximum recorded body length and maximum recorded body weight (both are not always coincidental with each other) in billfishes. The cross-sections of body and bill of each species are shown schematically on left and right, respectively (modified after Nakamura, 1983, Fig.54)

Furthermore, it has been shown that as billfishes grow larger, their bodies become much more robust, particularly in the case of Makaira indica (see Fig.4).

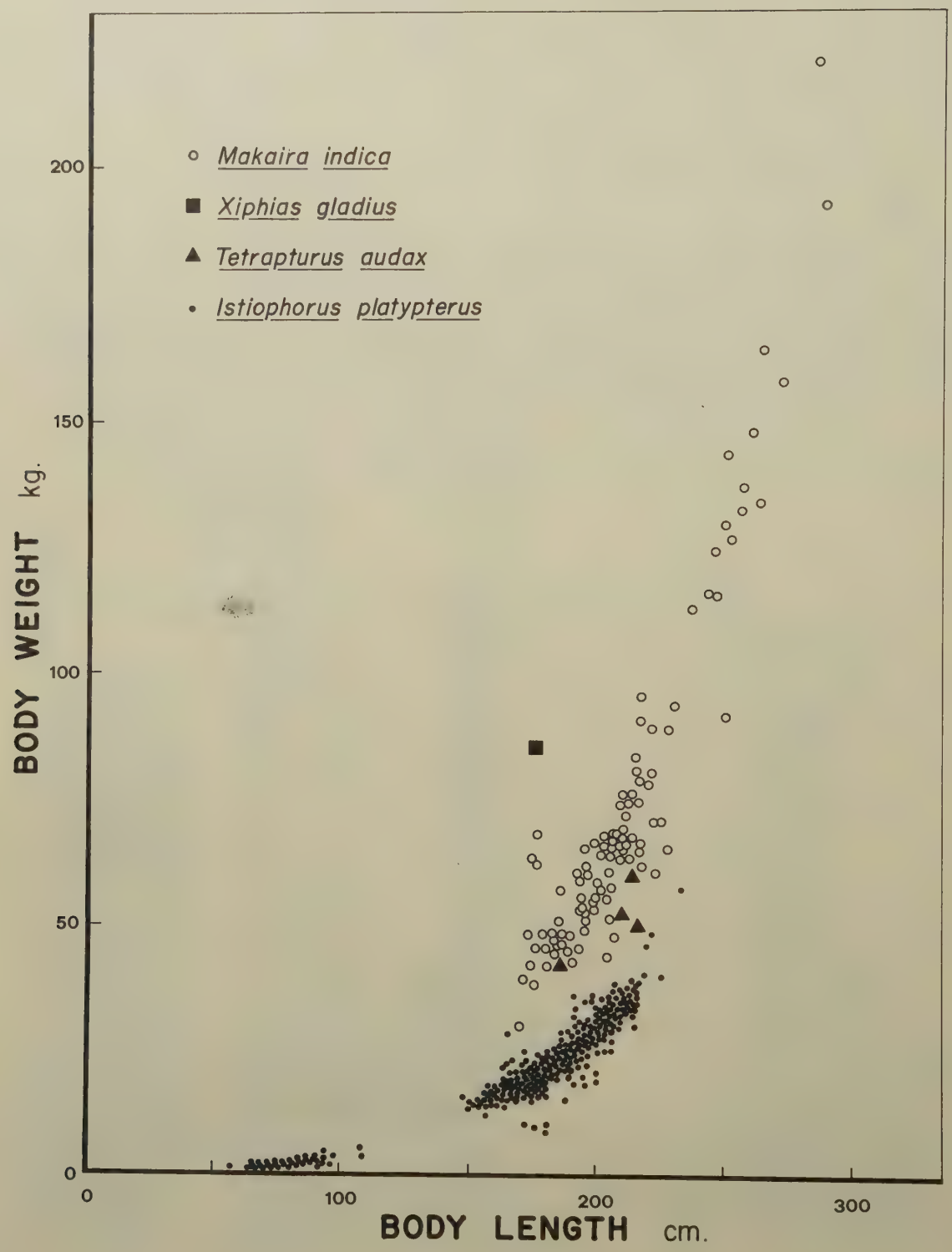


Fig.4 Length-weight relationships of billfishes caught by setnets and landed at Nishi-Maizuru Fish Market, Kyoto Pref., Japan between August 1976 and November 1978. Smaller I. platypterus (less than 110 cm body length) were weighed whole, the other large fishes of all species were weighed without gills or guts, and sometimes without the tip of the bill

Billfishes are primarily oceanic, epipelagic species inhabiting tropical and temperate waters, and seasonally also the cold waters of all oceans. They are usually confined to the water layers above the thermocline, but some may occur at greater depths (to below 800 m). The general distribution patterns of billfishes are summarized in Fig.5. While Xiphias gladius is cosmopolitan, the istiophorids have more restricted distributions. Although some billfish experts recognize only one cosmopolitan species of sailfish Istiophorus platypterus, the present author prefers, for the time being, to retain the traditional distinction between I. platypterus for the Indo-Pacific sailfish and I. albicans for the Atlantic sailfish, because there is evidence of some morphological differences between these two forms (see pages 16, 21, 23 and 24). If we consider the presence of spawning grounds to be a major element in the delimitation of principal areas of distribution, we may conclude that five of the species of Istiophoridae are confined to the Pacific and Indian oceans, six (if we recognize Tetrapturus georgei as valid) to the eastern Atlantic and five (if we recognize the Hatchet marlin as valid) to the western central Atlantic. Furthermore, three species, Makaira indica, Tetrapturus angustirostris and Tetrapturus audax have been shown to occur incidentally as "invaders" in the eastern Atlantic, which brings to 10 the number of species found at least occasionally in the Atlantic Ocean.

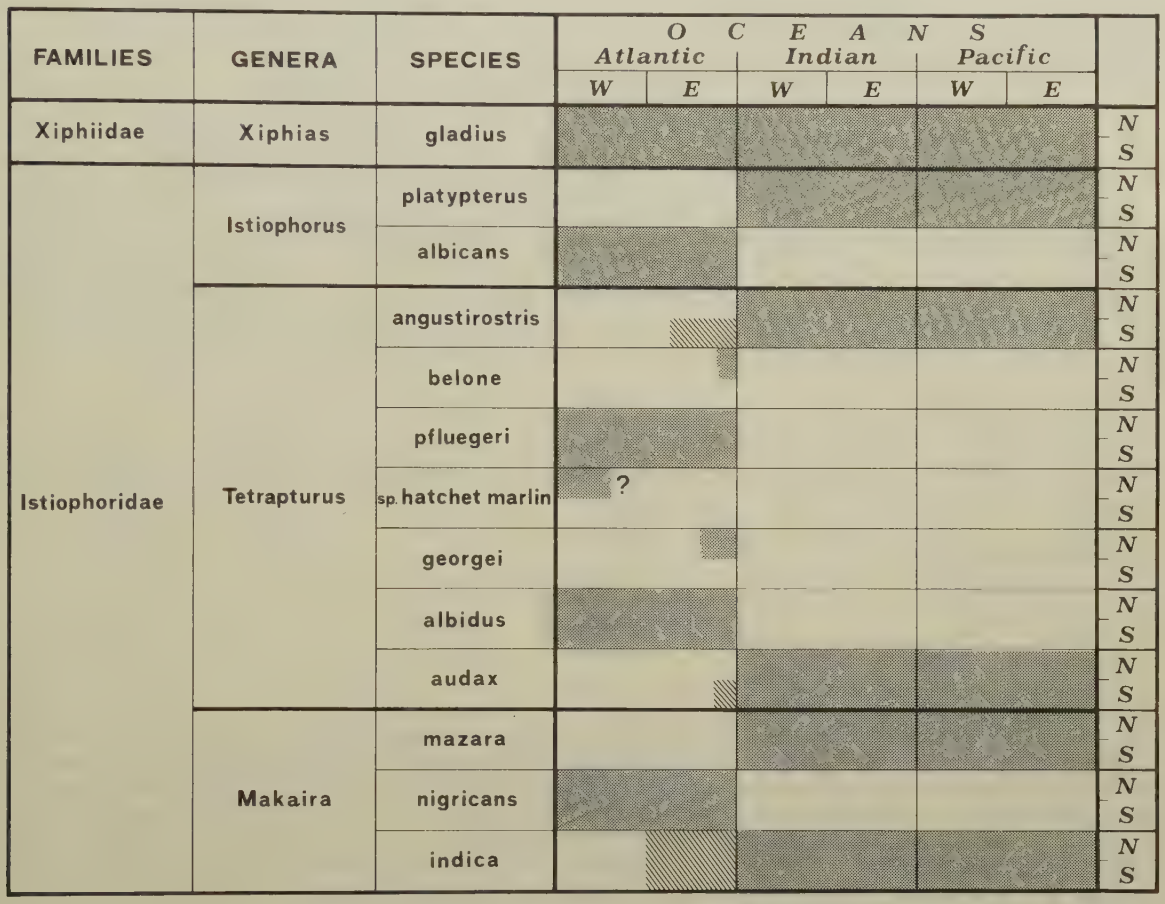


Fig.5 Schematic representation of the distribution of billfishes

W: Western; E: Eastern; N: Northern Hemisphere; S: Southern Hemisphere;

Principal distribution areas (including spawning grounds);

Areas of occasional distribution, or invasion, (no spawning)
(modified after Nakamura, 1983, Fig.61)

Istiophorus albicans, I. platypterus and Makaira indica migrate seasonally toward coastal waters, while T. angustirostris, M. mazara and M. nigricans are the most typically oceanic species. Roughly speaking, the migration pattern of all billfishes involves seasonal movements into temperate or cold waters for feeding and back to subtropical or tropical waters for overwintering and spawning. Although being among the largest and fastest bony fishes known from the sea, they seldom perform transoceanic migrations as is typical for the large tunas.

All species are dioecious (the sexes are separate) and their mating display is not completely known. None of the species are known to show sexual dimorphism in morphological features or colour pattern, but females of many species attain larger sizes than males. Batch-spawning of most species takes place in tropical and subtropical waters. The eggs are very small (about 1 mm in diameter) and pelagic, hatching out into planktonic larvae.

Billfishes are active and voracious predators, using their long rostrum for attacking their prey. Most likely there are no true, regular predators of billfishes, although they are preyed upon occasionally by many large oceanic fishes, such as tunas, wahoo, skipjack and dolfinfishes, particularly during their younger stages. The young are also taken sometimes by adult billfishes.

Being excellent foodfish, all species are of some importance to fisheries. Their commercial value is particularly high in Japanese markets. Most of them are exploited commercially by longliners and all are regarded as excellent and exciting targets by sportsfishermen. The recent world production of billfishes fluctuates around 95,000 metric tons per year (Table I) of which more than 90% is taken as bycatch in tuna longline fisheries. This bycatch represents in weight about 10% of the actual tuna catches (genus Thunnus). Japan produced about 70% of the world's catch and is the principal consumer country for these fishes. The species predominating in the catches are Xiphias gladius, Makaira mazara and Tetrapturus audax, accounting for about 40%, 23% and 17%, respectively, of the total world catch.

TABLE I

Estimated world catch of billfishes and tunas in metric tons (source: FAO, 1983, 1984)

Systematic Category	1978	1979	1980	1981	1982
Istiophorus albicans	267	2 823	1 320	1 091	920
Istiophorus platypterus	10 516	7 961	7 767	6 438	7 214
Makaira indica	2 909	3 440	2 465	2 453	2 373
Makaira mazara	18 193	18 654	21 109	21 413	20 727
Makaira nigricans	1 842	2 160	2 328	2 218	2 448
Tetrapturus albidus	204	93	119	121	131
Tetrapturus audax	15 426	15 988	18 429	15 664	15 460
Istiophoridae n.e.i.*	5 920	5 339	6 062	6 350	7 320
Subtotal Istiophoridae	55 277	56 483	59 599	55 748	56 593
Xiphias gladius	40 279	37 922	36 402	37 726	40 321
Subtotal Xiphiidae	40 279	37 922	36 402	37 726	40 321
Total Billfishes (Xiphioidei)	95 556	94 405	96 001	93 474	96 914
Thunnus alalunga	222 775	191 014	182 084	186 125	183 481
Thunnus albacares	521 466	537 987	522 412	560 274	535 725
Thunnus atlanticus	78	105	300	845	807
Thunnus maccoyii	32 415	35 475	39 186	37 226	29 005
Thunnus obesus	210 358	195 635	201 021	175 047	182 940
Thunnus thynnus	35 601	35 485	32 479	44 478	41 365
Thunnus tonggol	34	48	9	368	4 020
Total Thunnus	1 022 727	995 749	977 491	1 004 363	977 343
Ratio: Xiphioidei/Thunnus	0.093	0.095	0.098	0.093	0.097

* n.e.i. = not elsewhere identified

Billfishes are caught with a variety of fishing methods, such as longlining, trolling, harpooning, drift-netting, set-netting and others. The most important fishing method used in commercial fisheries is surface-longlining which was gradually developed by Japanese, Chinese (fishermen from Taiwan Province) and Korean fleets originally operating in the northwestern Pacific and then extending to other Pacific areas and to the Indian and Atlantic oceans. This method is also extensively used by other fishing nations, particularly the USSR and Cuba. On the other hand, sportsfishing is exclusively effected by trolling. Figure 6 represents the general distribution of commercial and sportsfishing areas for billfishes. The commercial longline fisheries cover nearly the entire natural distribution areas of the species, while all other fisheries are more restricted. The areas where commercial longline fisheries overlap with sportsfishing have recently been subjected to conflicts of interests in relation to the extension of Exclusive Economic Zones, and hence, fishing rights, to 200 miles offshore.

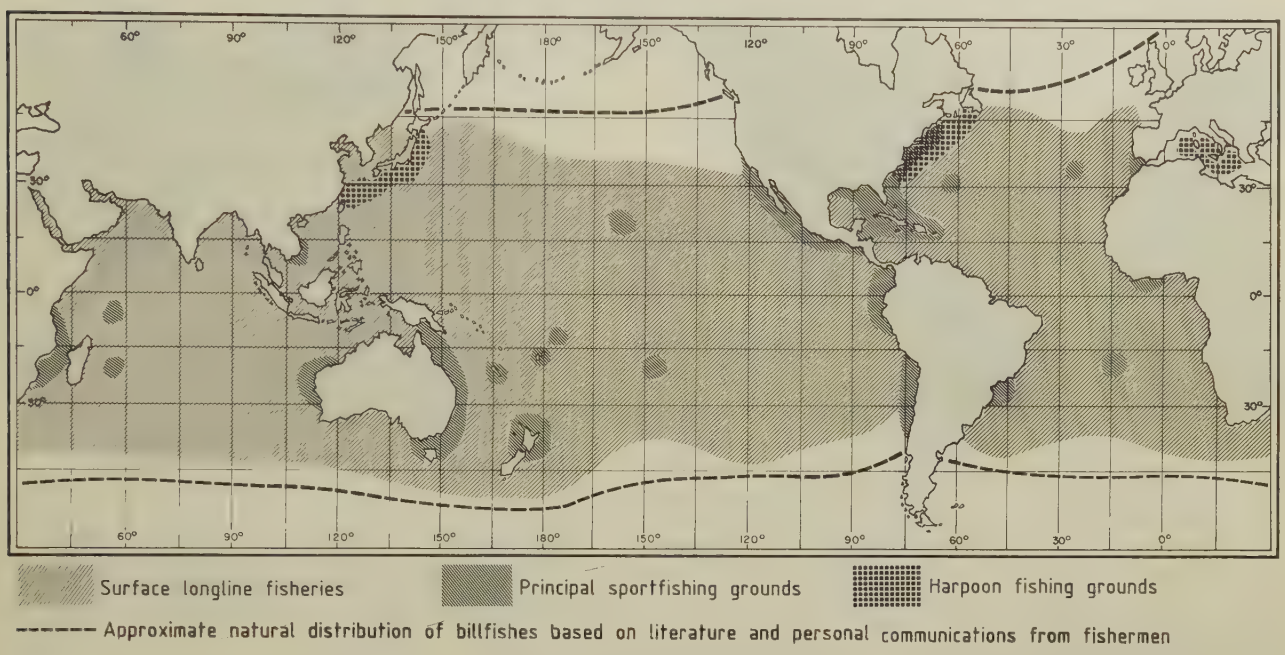

Surface longline fisheries
Principal sportfishing grounds
Harpoon fishing grounds
Approximate natural distribution of billfishes based on literature and personal communications from fishermen

Fig.6 Schematic illustration of the world's commercial and sport fisheries for billfishes (modified after Nakamura, 1983, fig.62)

Virtually all billfishes are highly appreciated for the excellent quality of their flesh. Fish over 20 kg are generally used for "sashimi" (sliced raw flesh with soy sauce and green mustard) and materials for "sushi" (sliced raw flesh with green mustard on vinegar-boiled rice balls). The colour of billfish flesh is usually paler than that of tuna. One of its advantages is that it does not change colour as easily as tuna flesh, thus withstanding longer periods of transportation and having a longer market shelf-life than tuna meat.

1.3 Illustrated Glossary of Technical Terms and Measurements

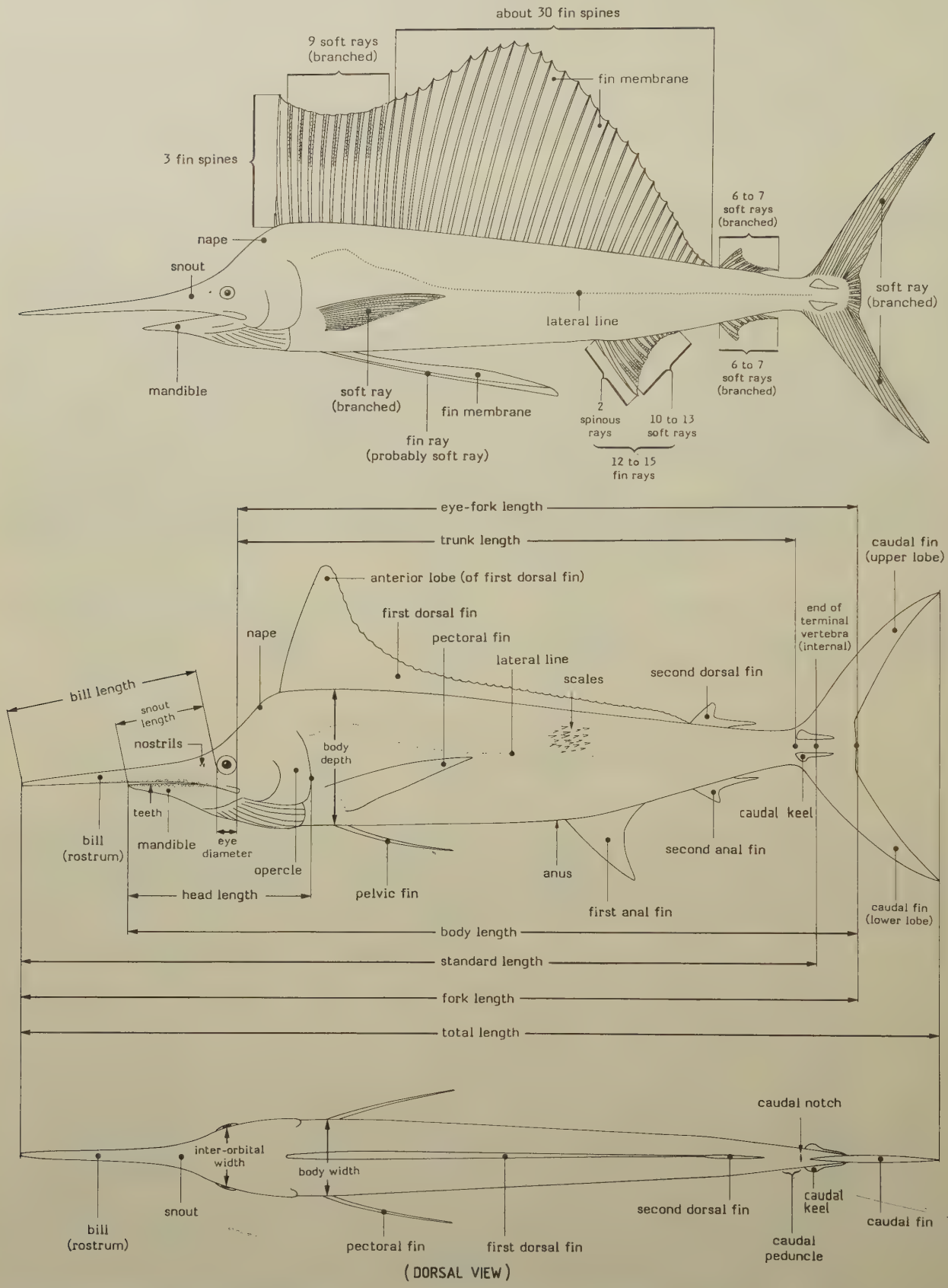
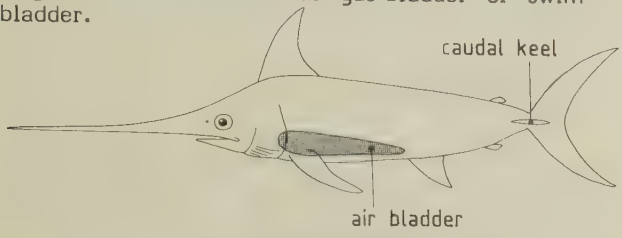


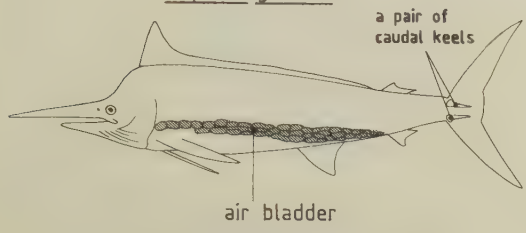
Fig.7 Schematic illustration of Indo-Pacific sailfish, Istiophorus platypterus (above) and a striped marlin, Tetrapturus audax (middle and below)

All measurements are straight line distances. For detail of measurements, see Rives (1956) and Nakamura (1983)

Air-bladder - Membranous sac filled with air or other gases lying in the abdomen just beneath the vertebrae. The swordfish's air-bladder consists of a single chamber (Fig.8a), while that of istiophorids is made up of many bubble-shaped, small chambers (Fig.8b). Also known as gas-bladder or swim-bladder.



a. Xiphias gladius



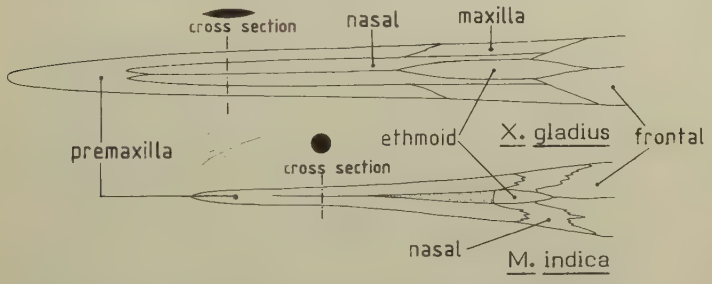
b. Makaira indica

Schematic illustration of air-bladder and caudal keels Fig.8

Anal fin(s) - The fin(s) on the ventral median line of the body behind the anus (Fig.7).

Anus - External opening of the intestine, situated on the ventral midline of the body (Fig.7). The relative position of the anus to the first anal fin is important in istiophorid taxonomy. Also known as vent.

Bill - Long, slender upper jaw. Both jaws are elongate, but the upper is longer than the lower in billfishes. The bill is flat in the swordfish and round in istiophorids (Figs 7,9).



Bill structure in dorsal view (schematic) Fig.9

Bill length - Meausred from the tip of the bill to the anteriormost point on the fleshy margin of the orbit (Fig.7).

Body depth - Greatest depth of body (Fig.7). Body depth at origin of pectoral fins, pelvic fins, and first anal fin is sometimes also used.

Body length - Measured from the tip of the lower jaw (with the jaws closed) to the posterior margin of the middle caudal rays (Fig.7). In other fishes the measurement, "body length" is usually "standard length". In billfish taxonomy, this dimension is used following Rivas (1956).

Body width - Greatest width of body (Fig.7). Body width at origin of pectoral fins, pelvic fins and first anal fin is sometimes also used.

Branchiostegal (rays) - Strut- or ray-like bones attached to the hyoid arch, connected by the branchiostegal membrane (Figs 15,16,22).

Branchiostegal membrane - The membrane connecting the branchiostegals and enclosing the gill chamber ventrally (Figs 15,16,22).

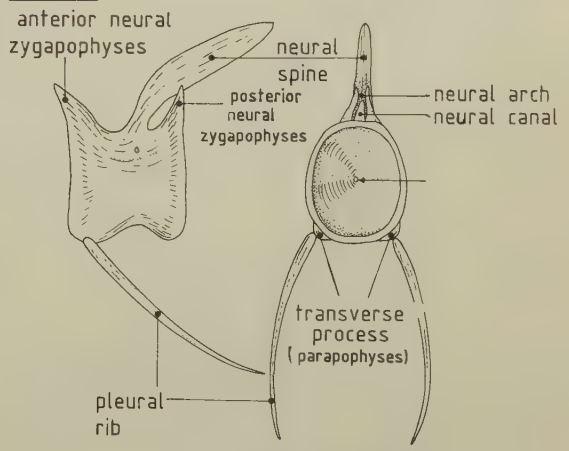
Caudal fin - Median fin situated at the posterior end of the body, consisting of an upper and a lower lobe (Fig.7).

Caudal keel - Xiphiidae have a large median caudal keel (Fig.8a) and Istiophoridae have a pair of caudal keels (Fig.8b) on the middle of the caudal peduncle.

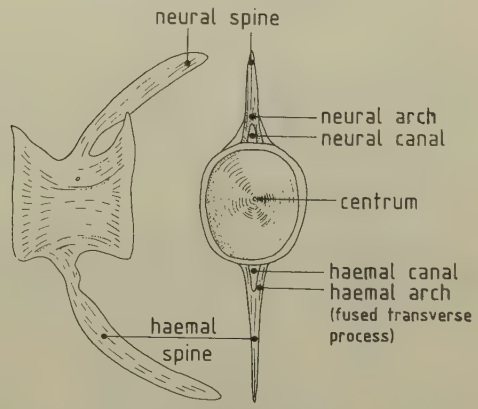
Caudal notch - An elongate, small pit on dorsal and ventral margins of the caudal peduncle (Fig.7). The caudal notch is shallow and small in istiophorids, and deep and rather large in Xiphias.

Caudal peduncle - The narrow part of the body between the posterior ends of the dorsal and anal fins and the base of the caudal fin (Fig.7).

Caudal vertebrae - Vertebrae that bear a haemal spine ventral to the vertebral centrum (Fig.10b). Caudal vertebrae lack pleural ribs. The number of caudal vertebrae is 15 or 16 in Xiphias 12 in Istiophorus and Tetrapturus, and 13 in Makaira.



a. precaudal vertebrae



b. caudal vertebrae

Schematic illustration of vertebrae of Xiphias gladius

Fig.10

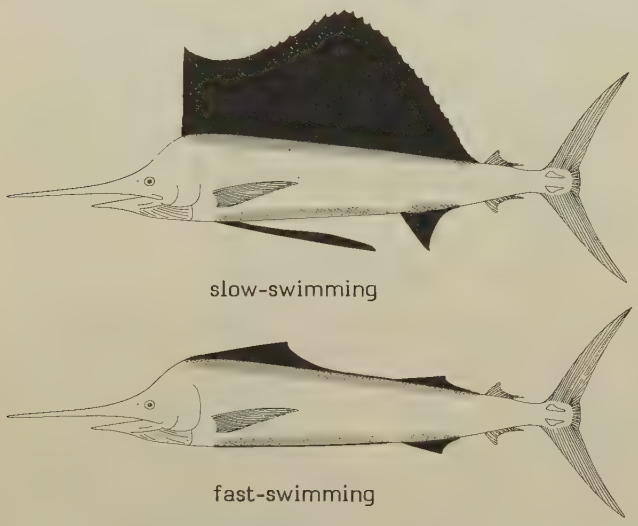
Dorsal fin(s) - Fin(s) on the back of a fish (Fig.7). Billfishes have two dorsal fins.

Ethmoid - Unpaired skull bone on the anterior part of the neurocranium (Fig.9).

Eye diameter - Measured as the greatest distance across the cornea, that is, between the margins of the cartilaginous eyeball (Fig.7).

Eye-fork length - Measured from the posterior edge of the orbit to the posterior margin of the middle caudal rays (Fig.7). This dimension is frequently used by Japanese fishery biologists because it is useful in specimens with bills cut at fish markets or on fishing boats.

Fin grooves - The first dorsal, first anal and pelvic fins fold down into grooves in all istiophorids when they are swimming rapidly (Fig.11). Fin grooves are not developed in Xiphias gladius.



Schematic illustration of fin grooves (shaded areas)in Istiophorus platypterus

Fig.11

Fin membranes - The thin membranes between the rays of the fins (Fig.7).

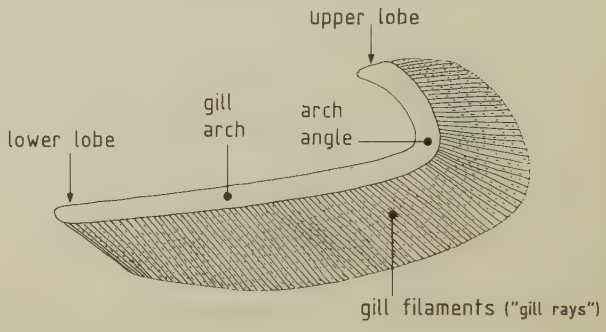
Fin rays - General term for the soft rays and spines (spinous rays) that support the fins (Fig.7). Soft rays are branched, segmented or paired (left and right elements united). Spines are unsegmented fin supports, unbranched, unpaired and usually stiff and sharply pointed.

Fin spines - Sharp, pungent and pointed structures (Fig.7). Usually called merely spines.

Fork length - Measured from the tip of the bill (upper jaw) to the posterior margin of the middle caudal rays (Fig.7). Usually used for scombroid (particularly tunas) studies, because the caudal fork area is very strong, in tunas as well as in billfishes and the snout is not prolonged in tunas.

Frontals - Paired skull bones in middle part of the neurocranium (Figs 9,16).

Gill arch - The J-shaped structure under the gill cover that bears the gill filaments and normally the gillrakers, but the billfishes lack gillrakers (Fig. 12). There are 4 gill arches on each side of billfishes.



first gill arch of Xiphias gladius (schematic)

Fig.12

Gill filaments - Organ for aquatic respiration. In billfishes the gill filaments are ossified as "gill rays" as in the case of tunas (Fig.12); see also Iwai & Nakamura (1964).

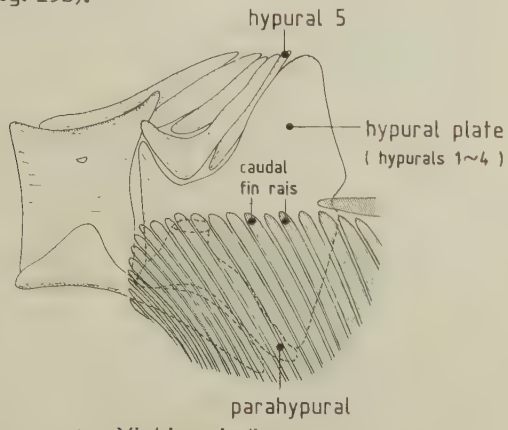
Haemal arch - The arch that is formed above the fused distal ends of the haemal spines of caudal vertebrae (Fig.10b).

Haemal canal - The canal for the blood vessel, formed by the haemal arch of caudal vertebrae (Fig.10b).

Haemal spines - The spines that extend ventrally from the centra of a caudal vertebra (Fig.10b). The first vertebra with a haemal spine is the first caudal vertebra.

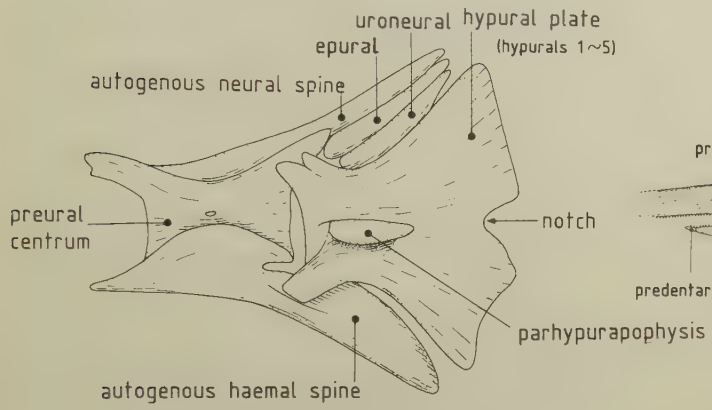
Head length - Measured from the tip of the mandible (lower jaw) to the most distant point on the opercular membrane (Fig.7).

Hypural plate - The expanded ends of the hypural bones form a wide, fan-like plate onto which the caudal fin rays insert distally. Like tunas, billfishes differ from most other fishes in having the caudal fin rays so deeply divided that they completely cover the hypural plate; the hypural plate consists of four hypural bones in Xiphias (Fig.13a) and five in Istiophoridae (Fig. 13b).



a. Xiphias gladius

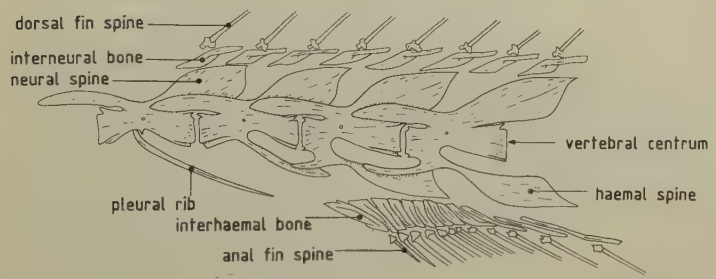
(Caudal fin rays shown only on lower half)



b. Istiophorus platypterus

Schematic drawing of hypural plate Fig.13

Interhaemal bones - The bones situated between the haemal spines of the vertebrae and the spines or rays of the anal fin (Fig.14).

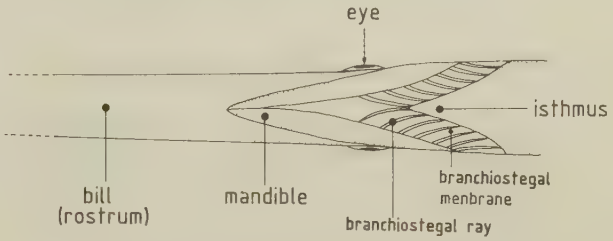


Position of interneural and interhaemal bones in Istiophorus platypterus (schematic) Fig.14

Interneural bones - The bones situated between the neural spines of the vertebrae and the spines or rays of the dorsal fin (Fig.14).

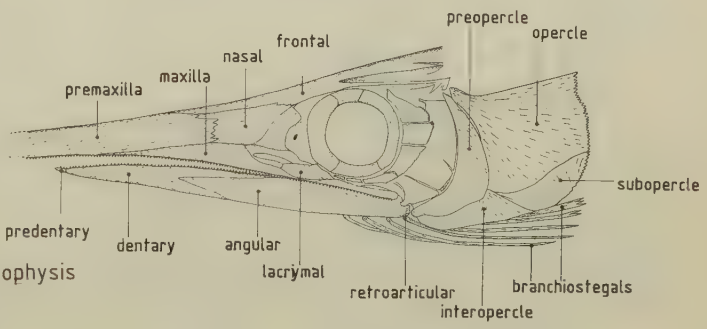
Interorbital width - Measured as the shortest distance between the fleshy margins of the orbits (Fig.7).

Isthmus - Ventral fleshy area on the throat between the gills (Fig.15).



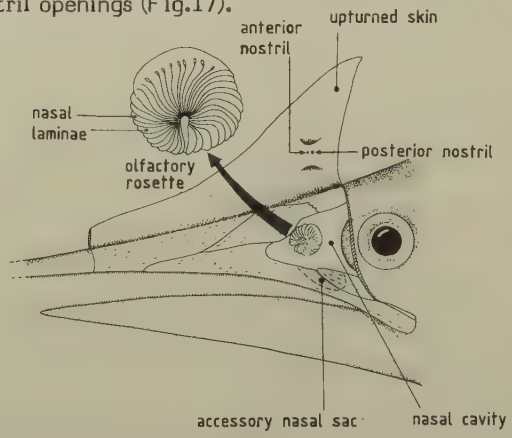
Head of Xiphias gladius in ventral view (schematic) Fig.15

Lacrymal bone - The largest of the infraorbital series of bones, located ventrad and slightly anterior to the eye (Fig.16). Also known as preorbital bone or first infraorbital bone.



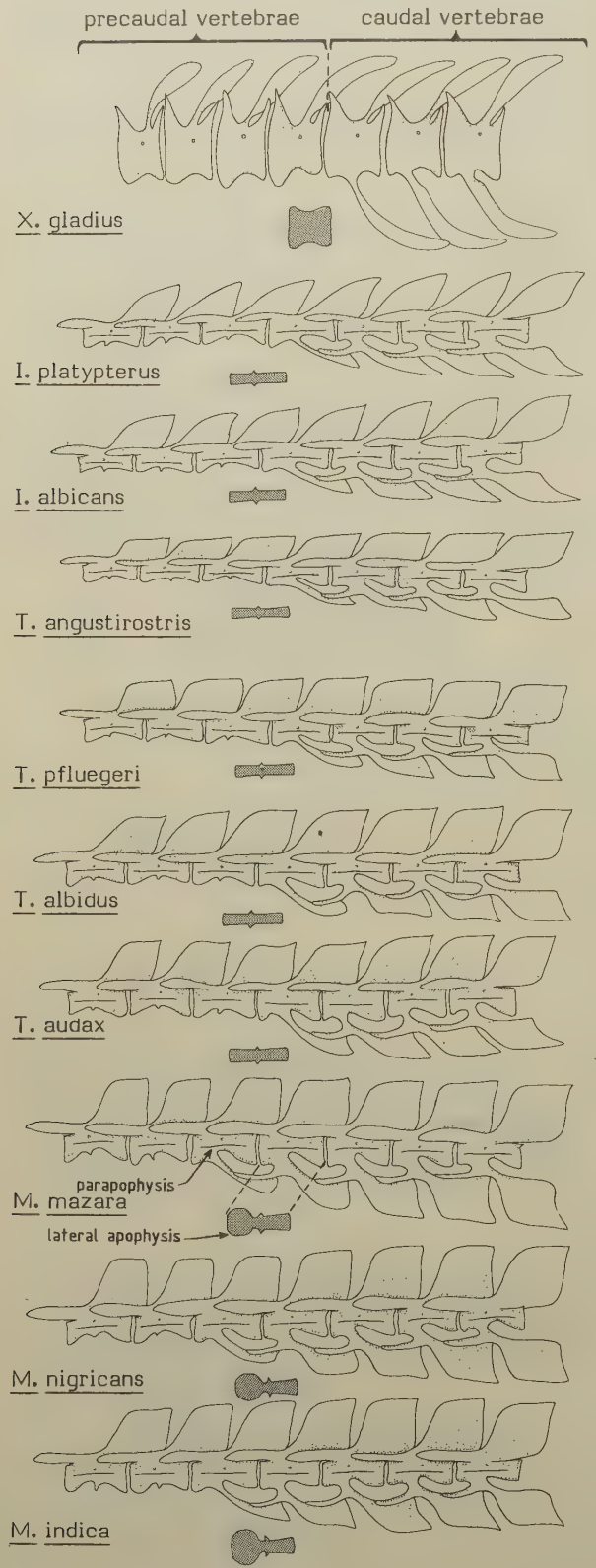
Lateral view of head skeleton of Istiophorus platypterus (schematic) Fig.16

Laminae of the olfactory rosette - Fleshy folds (nasal laminae) containing cells that can detect odours, arranged in a radiate pattern (rosette) beneath the skin between the anterior and posterior nostril openings (Fig.17).



Nasal cavity of Istiophorus platypterus after dissection (schematic) Fig.17

Lateral apophyses - The flanges that extend laterally from the anterior part of each vertebral centrum (Fig.18). Also known as the transverse flanges.



Lateral apophyses of billfish vertebrae (schematic). White areas: lateral view; black areas: ventral view

Fig.18

Lateral line - A series of sense organs enclosed in tubular scales along the sides of the body (Fig.7). The lateral line is looped in Makaira mazara and reticulate in Makaira nigricans. Other istiophorids have a single lateral line. Xiphias gladius has a single lateral line in immature stages which disappears in the adult.

Mandible - Known as the lower jaw (Figs 7, 15), consisting of predentary (Istiophoridae only), dentary, angular and retroarticular bones (Fig.16).

Maxilla - The supporting bone of the premaxilla which bears teeth in the upper jaw (Figs 9,16). The maxilla itself also bears teeth in istiophorids, unlike most other fishes.

Nape - Dorsum of the neck area immediately posterior to the head (Fig.7).

Nasals - Paired bones in the ethmoid region of the neurocranium (Figs 9,16).

Neural arch - The arch that is formed below the fused basal part of the neural spine of the vertebrae (Fig.10).

Neural canal - The canal for the nerve cord formed by the neural arch (Fig.10).

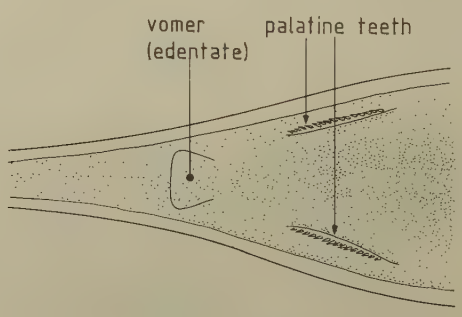
Neural spines - The spines that extend dorsally from the centra of a vertebra (Fig.10).

Nostrils - External openings of the nasal cavity. There are two (anterior and posterior) nostrils in billfishes (Figs 7,17).

Operculum - Gill cover, supported by four bones: opercle, preopercle, interopercle and subopercle (Figs 7,16).

Orbit - The eye socket (Fig.16). The sclera is ossified in billfishes.

Palatine - A pair of plow-shaped bones, the ventral margin of which lies in the roof of the mouth. The palatine bones may be toothed in istiophorids (Fig. 19), but are edentate in Xiphias.



Roof of mouth in Tetrapturus albidus (schematic)

Fig.19

Parapophyses - (Transverse processes). Projections from the ventral centra of the vertebrae (Fig.10).

Pectoral fins - Lateral paired fins behind the head (Fig.7).

Pelvic fins - Paired fins on the ventral edge of anterior body (Fig.7). Also known as ventral fins.

Precaudal vertebrae - The anterior vertebrae without haemal spines (Figs 10a,18). Also known as abdominal vertebrae. The number of precaudal vertebrae is 10 or 11 in Xiphias, 12 in Istiophorus and Tetrapturus and 11 in Makaira.

Premaxillae - Paired bones of the upper jaw, usually bearing teeth in higher teleosts and associated with the maxillae (Figs 9,16).

Predentary - Unpaired bone anterior to the dentary. Present in Istiophorids (Figs 16,22), but absent in Xiphias.

Rostrum - Projecting snout ;or bill (Figs 7,9).

Scales - Thin, flat, bony plates covering the body, usually cycloid or ctenoid. The scales of istiophorids do not fit into these categories, they are elongate and pungent, with sharp posterior points (Fig.7). The arrangement and shape of the scales are useful characters for the identification of billfishes. Xiphias has no scales in the adult stage.

Snout - Forward part of the head, anterior to the eyes and above the mouth (Fig.7).

Snout length - Measured from the tip of the mandibule (lower jaw) to the anteriormost point on the fleshy margin of the orbit (Fig.7) in billfishes.

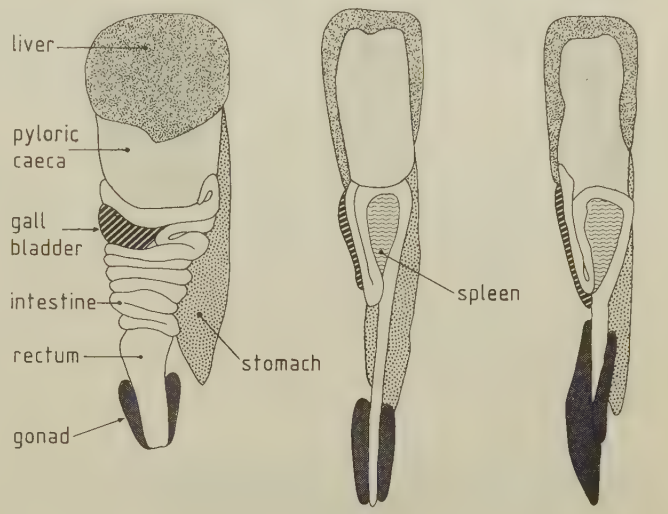
Standard length - In systematic studies, the standard length is the distance from the anteriormost part of the snout to the caudal fin base (theoretically to the end of the terminal vertebra, but this is not practical in general use) (Fig.7). In fishery studies the fork length, e.g., the distance from the anteriormost point of the head to the posterior margin of the middle caudal rays is used.

Total length - Straight-line measurement from the anteriormost to the posteriormost point of the fish (Fig.7).

Trunk length - Measured from the posterior edge of the orbit to the anterior insertion of the caudal keels (Fig.7). Used in sport-fishing.

Vertebra - One of the bony or more or less cartilaginous (in primitive fishes or young fishes) segments composing the spinal column or backbone (Figs 10,18). Number of vertebrae = number of precaudal vertebrae plus number of caudal vertebrae: 26 in Xiphiidae (Xiphias) and 24 in Istiophoridae (Istiophorus, Tetrapturus and Makaira).

Viscera - Internal organs of the body which are well developed in all the species of billfishes (Fig.20). The intestine is coiled, the spleen is not visible in ventral view, and the gonads are symmetrical in Xiphias (Fig.20a). The spleen is visible in ventral view, and the intestine is undulated in Istiophoridae (Fig.20b,c). The gonads are symmetrical in Istiophorus (Fig.20b), in Makaira, and apparently in Tetrapturus except T. angustirostris and T. pfluegeri where they are asymmetrical and Y-shaped (Fig.20c) (possibly also in T. belone).



a. Xiphias gladius b. Istiophorus platypterus c. Tetrapturus angustirostris

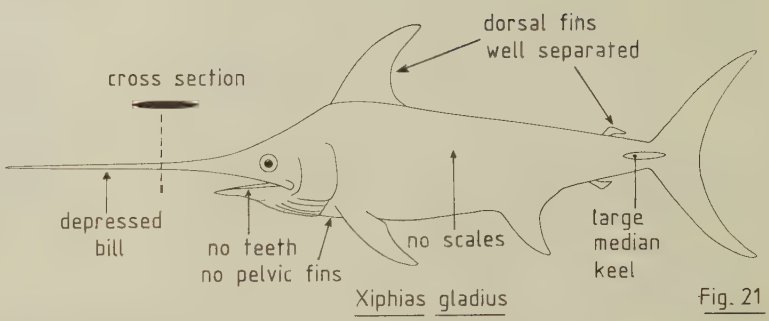
Viscera of billfishes in ventral view (schematic)
Fig.20

Vomer - A median skull bone, the ventral surface of which lies in the roof of the mouth. The vomer is edentate in billfishes (Fig.19), but many other fishes have vomerine teeth.

2. SYSTEMATIC CATALOGUE

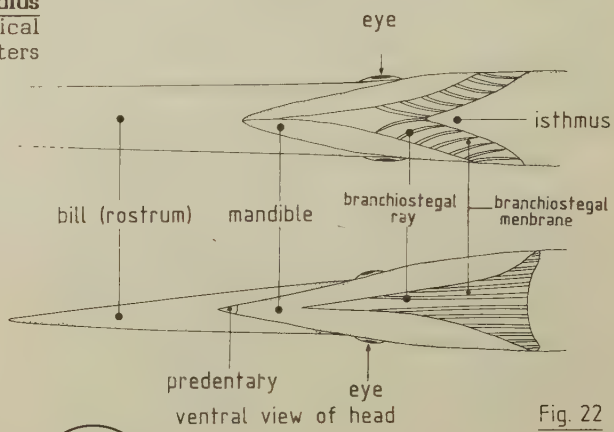
2.1 Illustrated Key to Genera and Species

1a. No pelvic fins; a large median keel on each side of caudal peduncle region; snout extremely long, forming a sword-like bill, depressed in cross-section; first dorsal fin short-based, well separated from second dorsal fin in adults (Fig. 21); no scales on body nor teeth in jaws in adults; right and left branchiostegal membrane separated distally (Fig.22a); vertebrae 26 ..... **Xiphias gladius**
Worldwide in tropical and temperate waters



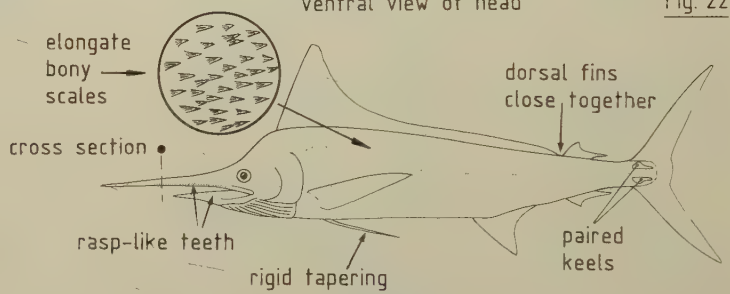
Xiphias gladius Fig. 21

1b. Rigid, tapering pelvic fin present; a pair of caudal keels on each side of caudal peduncle region; snout long to somewhat shorter, round in cross-section; first dorsal fin long-based, close to second dorsal fin (Fig.23); body covered with small, elongate bony scales; rasp-like small jaw teeth present in adults; right and left branchiostegal membranes united broadly (Fig. 22b); vertebrae 24



ventral view of head Fig. 22

2a. First dorsal fin (X) sail-like and remarkably higher than body depth (Y) at level of midbody; pelvic fin rays very long, nearly reaching to anal fin origin, with well developed membrane (Fig.24)



T. audax Fig. 23

3a. Pectoral fins and caudal fin short in immature specimens up to about 90 cm body length (Fig.25); attains greater size (about 100 kg maximum body weight) than Atlantic sailfish ..... **Istiophorus platypterus**
Pacific and Indian oceans

3b. Pectoral fins and caudal fin long in immature specimens to about 90 cm body length (Fig. 26); attains smaller size (about 60 kg maximum body weight) than Indo-Pacific sailfish ..... **Istiophorus albicans**
Atlantic Ocean

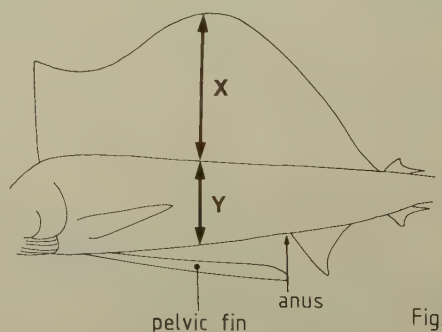
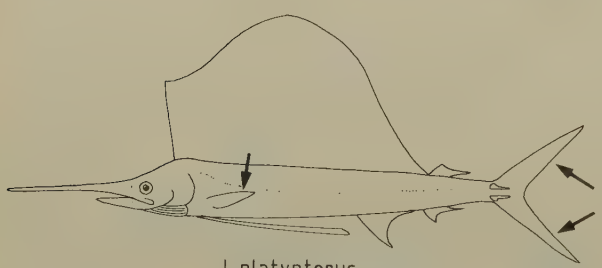
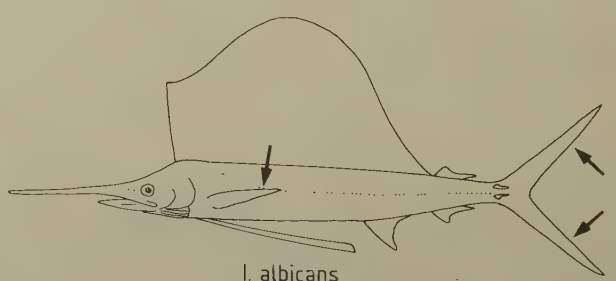


Fig. 24


I. platypterus
(immature specimen) Fig. 25


I. albicans
(immature specimen) Fig. 26

2b. First dorsal fin (X) lower than body depth (Y) at level of midbody, not sail-like; pelvic fin rays short, well separate from origin of anal fin, with moderately developed membrane (Fig. 27)

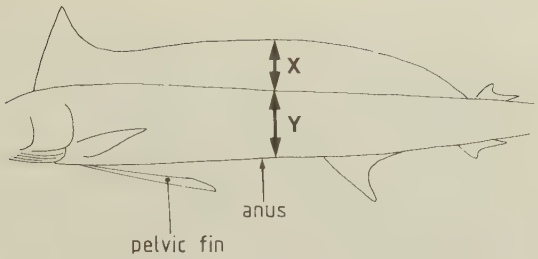


Fig. 27

4a. Height of anterior lobe of first dorsal fin (X) slightly greater than, or nearly equal to, body depth (Y); nape slightly elevated or not elevated (Fig.28); body well compressed laterally; vertebrae 12+12=24

5a. Anterior lobe of first dorsal fin slightly higher than rest of fin which remains of about equal height almost to the end (Figs 27,30,31,32); anus situated far anterior to first anal fin origin (Fig.29), the distance between them (X) greater than height of first anal fin (Y)

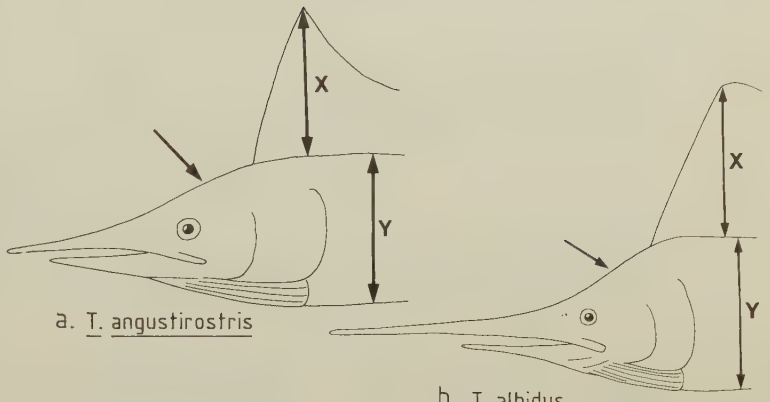


Fig. 28

6a. Bill short, its length (X) usually equal to, or shorter than, head length (Y); pectoral fins narrow and short, less than 18% of body length (Figs 30, 31)

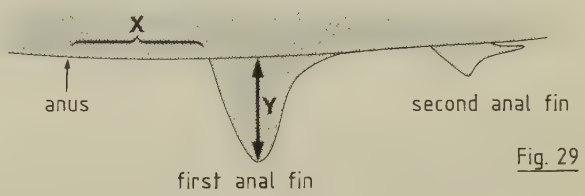
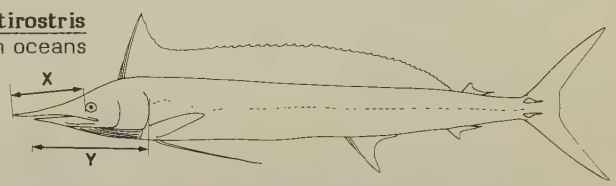


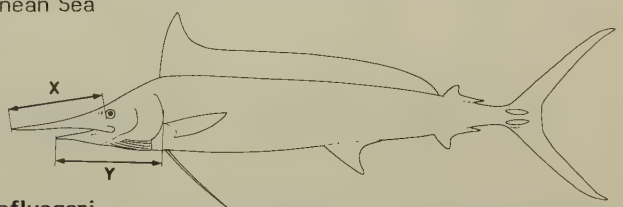
Fig. 29

7a. Bill very short, less than 15% of body length (Fig. 30) .. **Tetrapturus angustirostris**
Pacific and Indian oceans



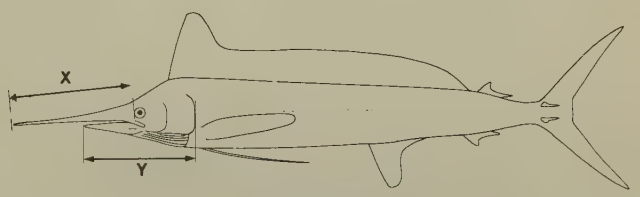
T. angustirostris Fig. 30

7b. Bill moderately short, less than 18% of body length (Fig. 31) ..... **Tetrapturus belone**
Mediterranean Sea



T. belone Fig. 31

6b. Bill long, its length (X) usually equal to, or longer than, head length (Y); pectoral fins wide and long, more than 18% of body length (Fig. 32) ..... **Tetrapturus pfluegeri**
Atlantic Ocean



T. pfluegeri Fig. 32

5b. Anterior lobe of first dorsal fin somewhat higher than remainder of the fin, the height decreasing gradually backward (Figs 34,35,36); anus situated near origin of first anal fin (Fig.33), the distance between them (X) smaller than height of first anal fin (Y)

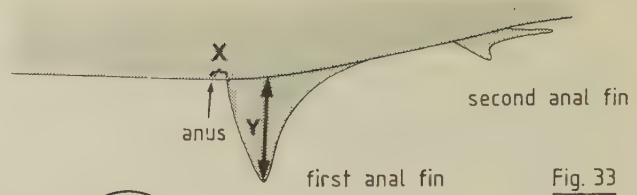
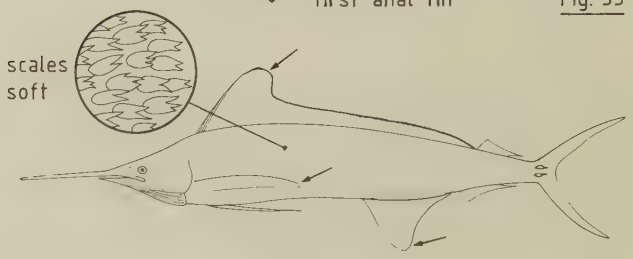


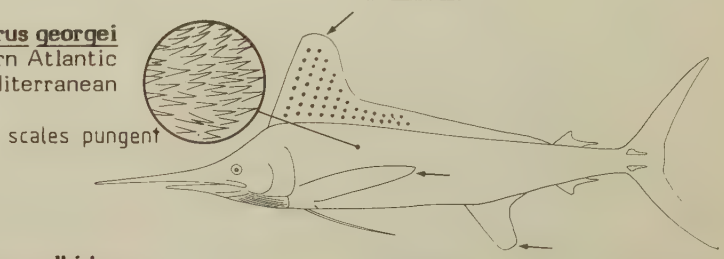
Fig. 33

8a. Tip of first dorsal fin, pectoral fins and first anal fin rounded (Figs 34,35)



T. georgei Fig. 34

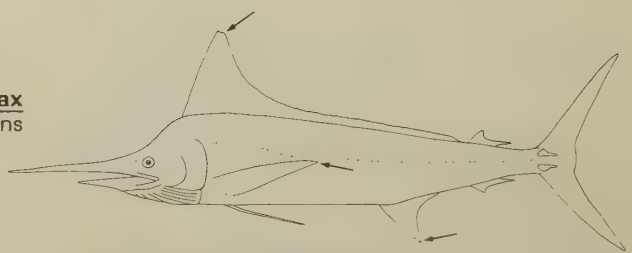
9a. First dorsal fin unspotted; scales on midbody soft and rounded (Fig.34).... **Tetrapturus georgei**
Eastern Atlantic and Mediterranean



T. albidus Fig. 35

9b. First dorsal fin spotted; scales on midbody pungent, each scale elongate with 1 or 2 spines (Fig. 35) ..... **Tetrapturus albidus**
Atlantic Ocean

8b. Tip of first dorsal fin, pectoral fins and first anal fin pointed (Fig.36) ..... **Tetrapturus audax**
Pacific and Indian oceans


T. audax Fig. 36

4b. Height of anterior lobe of first dorsal fin (X) lower than body depth (Y); nape highly elevated (Fig.37); body not compressed laterally; vertebrae 11+13=24

10a. Pectoral fins can be folded back against sides of body

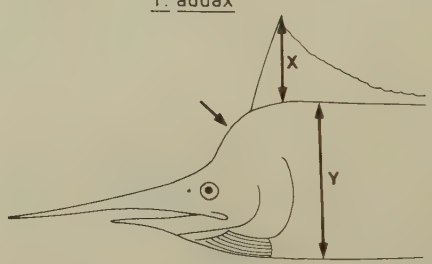
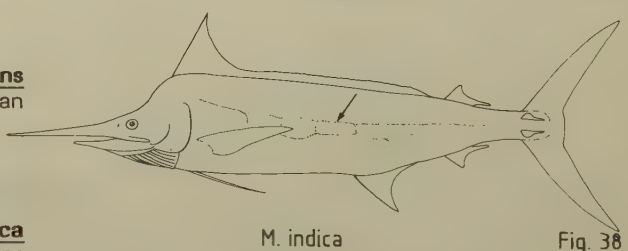


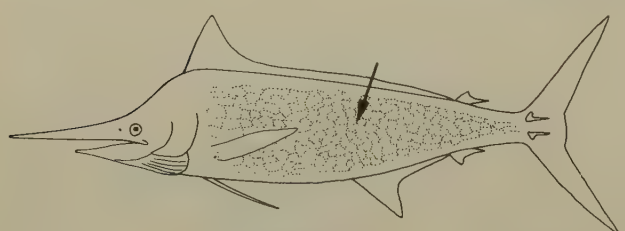
Fig. 37

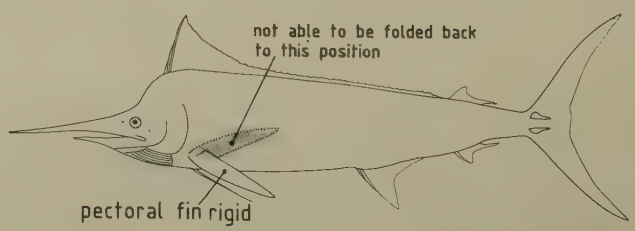
11a. Lateral line system with simple loops (Fig.38) ..... **Makaira mazara**
Pacific and Indian oceans

11b. Lateral line system reticulated (Fig.39)..... **Makaira nigricans**
Atlantic Ocean


M. indica Fig. 38

10b. Pectoral fins rigid, cannot be folded back against sides of body (Fig.40)..... **Makaira indica**
Pacific and Indian oceans

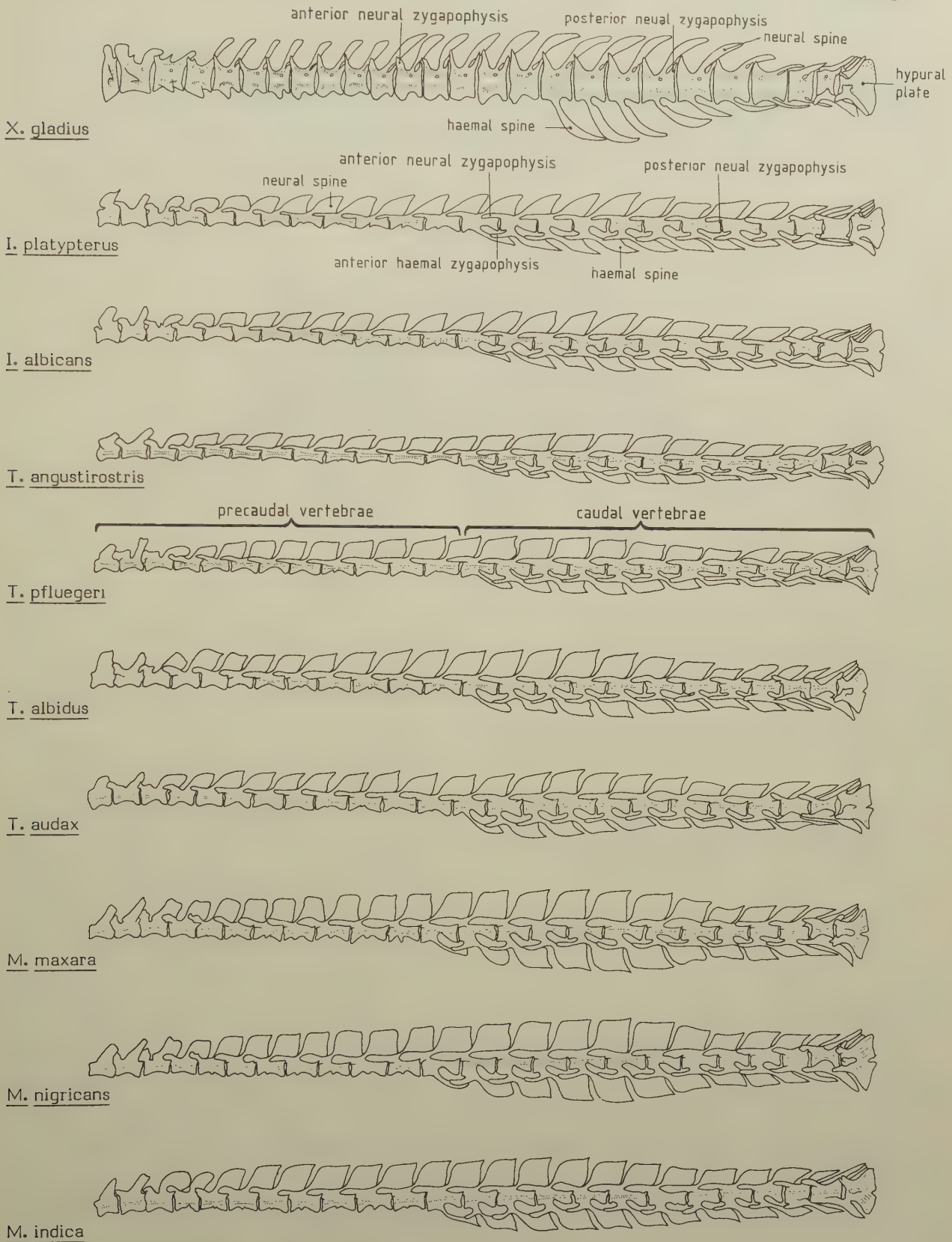

M. nigricans Fig. 39



M. indica Fig. 40

2.2 Additional Aids to Identification of Genera and Species

The shape of vertebrae of billfishes shows characteristic variations by species or genus and may be used as an additional aid to species identification, especially in the case of specimens that are damaged or cut (Fig.41)



Vertebrae of billfishes (modified after Nakamura, 1983, Fig.10) Fig.41

2.3 FAMILY ISTIOPHORIDAE

ISTIO

Synonymy : Histiophoridae; Makairidae; Tetrapturidae.

FAO Names : En - Marlins, Sailfishes, Spearfishes; Fr - Makaires, Marlins, Voiliers; Sp - Agujas, Marlines, Peces vela.

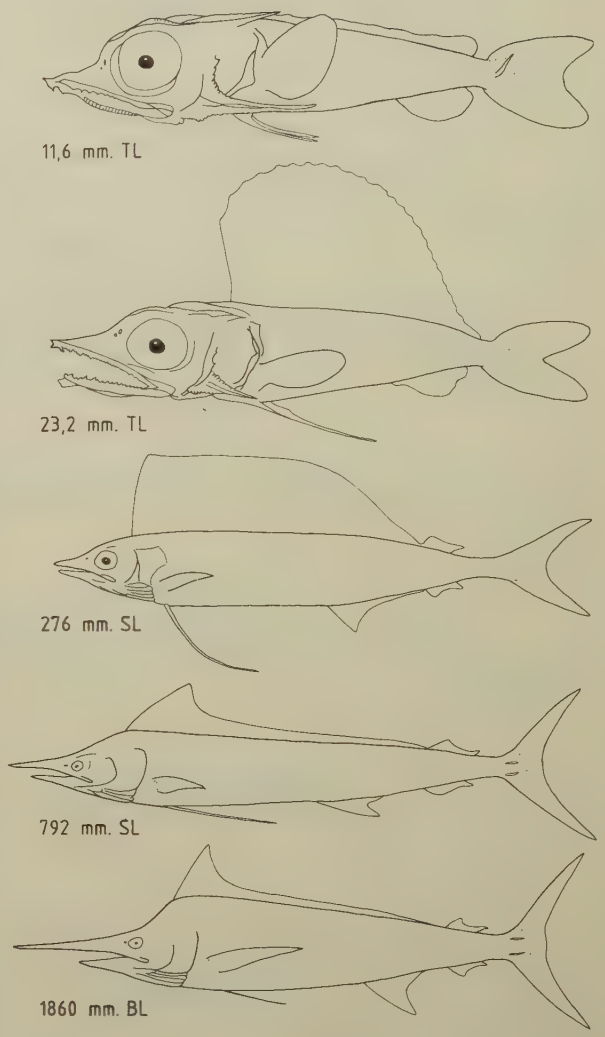
Field Marks : Bill long, round in cross-section; double keels on each side of caudal peduncle; scales ossified and elongate, each with one to several points posteriorly; pelvic fins rigid, string-like, depressible into a ventral groove; vertebrae 24, with plate-like spines.

Diagnostic Features : Premaxilla elongate, forming a long, pointed rostrum, round in cross-section; jaws with file-like teeth in adults; branchiostegal membranes entirely united to each other and free from isthmus; gillrakers absent. Caudal peduncle fairly depressed and slightly compressed, with 2 keels on each side and a shallow notch on dorsal and ventral profiles. Pelvic fins with one spine and 2 soft rays fused together, depressible into a groove. Body covered with elongate scales, each with one to several points. Vertebrae 24, with plate-like neural and haemal spines (triangular to square).

Habitat, Distribution and Biology : Istiophorids are primarily inhabitants of warm seas, usually swimming in the upper layers of water above the thermocline. They often migrate into temperate or cold waters to feed on forage organisms during the warmer season and back to warm waters for spawning or over-wintering during the colder season. Being among the largest and swiftest teleosts of the oceans, they perform considerably long migrations but only few records of transoceanic migrations are known for this group.

Interest to Fisheries : All istiophorid species have some commercial value throughout the world, but they are most highly priced in Japan which is the major consumer nation for this group of fishes. Most of the species are exploited commercially by longline fleets and all are regarded as excellent game fish by sports fishermen.

Remarks : The species of this family undergo drastic morphological changes during growth, as is shown in the illustrated example of Makaira mazara.



Body changes of Makaira mazara with growth (schematic)

Istiophorus Lacepède, 1801

ISTIO Istio

Genus : Istiophorus Lacepède, 1801, Histoire naturelle des poissons, 3:374-5.

Type Species : Istiophorus gladifer Lacepède, based on "Le voilier" of Broussonet, Mem.Acad.Sci., 1786: 450-5, pl. 10.

Synonymy : Nostidium Hermann, 1804; Histiophorus Cuvier, in Cuvier and Valenciennes, 1832; Skeponopodus Nardo, 1833; Zanclurus Swainson, 1839.

Remarks : There are many research workers who consider that this genus is monotypic, including only Istiophorus platypterus. Others recognize two species (or subspecies).

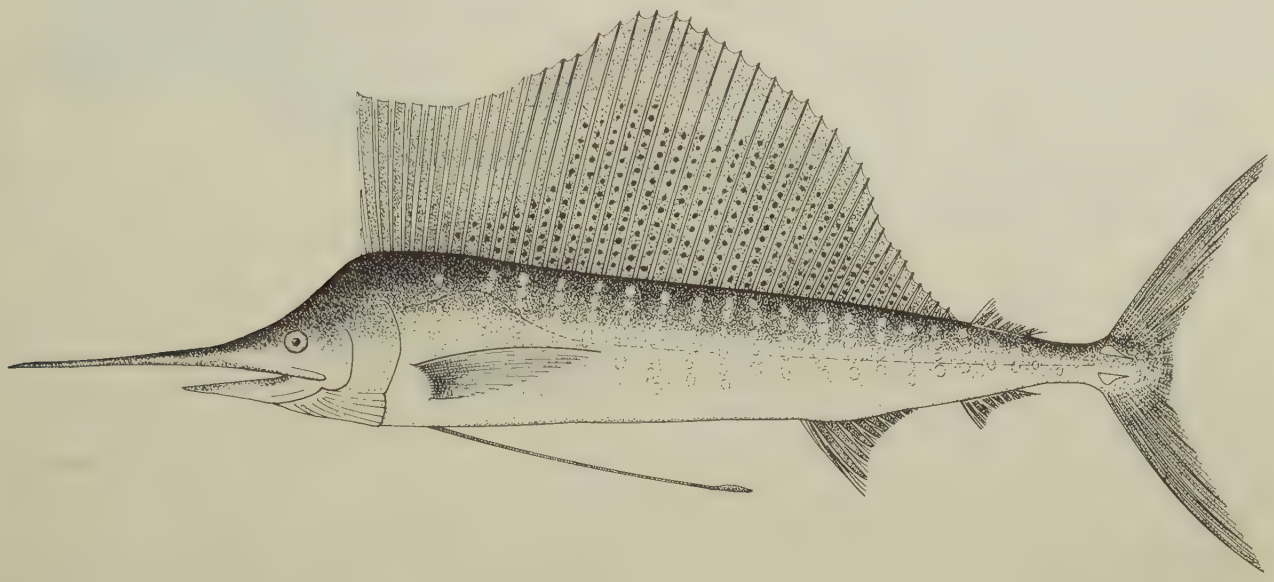
Istiophorus albicans (Latreille, 1804)

ISTIO Istio 1

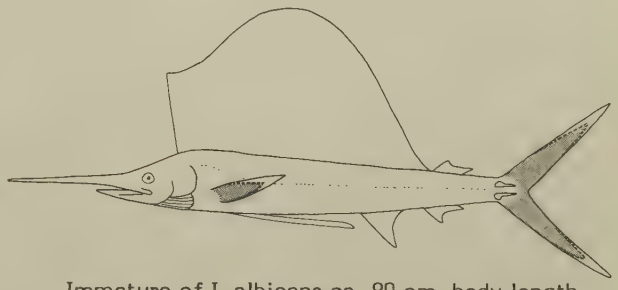
Makaira albicans Latreille in Bosc & Latreille, 1804, Nouveau Dictionnaire d'Histoire Naturelle, 1(24):104 (Brazil).

Synonymy : Histiophorus americanus Cuvier in Cuvier & Valenciennes, 1832; Histiophorus pulchellus Cuvier in Cuvier & Valenciennes, 1832; Makaira velifera Cuvier, 1832; Skeponopodus guebucu Nardo, 1833; Histiophorus granulifer Castelnau, 1861; Xiphias velifer Rochebrune, 1882; Istiophorus americanus-Jordan, 1885; Istiophorus wrigthi Jordan & Evermann, 1926; Istiophorus maguirei Jordan & Evermann, 1926; Istiophorus volador Jordan & Evermann, 1926; Histiophorus albicans-Whitley, 1936; Istiophorus albicans-Whitley, 1937.

FAO Names : En - Atlantic sailfish; Fr - Voilier de l'Atlantique; Sp - Pez vela del Atlántico.

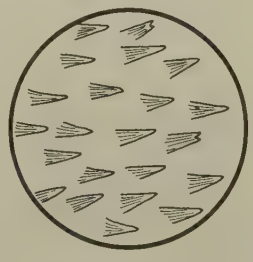


Field Marks : First dorsal fin sail-like and remarkably higher than greatest body depth; pelvic fins very long, nearly reaching to anus, with a well developed membrane; pectoral and caudal fins long compared with those of Istiophorus platypterus in young fish up to about 90 cm body length.



Immature of I. albicans ca. 90 cm. body length
(screened areas show characters of I. platypterus)

Diagnostic Features : Body fairly compressed. Bill long, slender and round in cross section; jaws and palatines with small, file-like teeth in adults; no gillrakers; right and left branchiostegal membranes united to each other, free from isthmus. Two dorsal fins, the first large, with 42 to 46 rays, the second small with 6 or 7 rays; first dorsal fin sail-like, remarkably higher than body depth at level of midbody, its base long and close to that of second dorsal fin; two anal fins, the first with 11 to 14, the second with 6 or 7 rays; position of second anal fin slightly more forward than that of second dorsal fin; pectoral fins with 17 to 20 rays, relatively longer than in I. platypterus in immature specimens (to about 90 cm body length); pelvic fins extremely long, almost reaching to anus, depressible into a groove, with one spine and several soft rays fused tightly together and with a well developed membrane. Caudal peduncle with double keels on each side and a shallow caudal notch on both, the dorsal and the ventral surfaces; anus situated near to first anal fin origin. Lateral line single and well visible. Scales vary in shape with growth (see I. platypterus); in adults they are somewhat sparse, imbedded in the skin, each with a single, rather blunt point or two posterior points. Vertebrae 24 (12 precaudal and 12 caudal). Colour: body dark blue dorsally, light blue splattered with brown laterally, and silvery white ventrally; about 20 rows of longitudinal stripes on sides, each stripe composed of many light blue round dots. Bases of first and second anal fins often tinged with silvery white; membrane of first dorsal fin dark blue or blackish blue, with scattered small round black dots; remaining fins blackish blue, sometimes tinged with dark brown.



scales

Geographical Distribution: I. albicans is widely distributed in the tropical and temperate waters of the Atlantic Ocean. The latitudinal range, based on data from longline catches, is approximately 40°N in the western North Atlantic, 50°N in the eastern North Atlantic, 40°S in the western South Atlantic, and 32°S in the eastern South Atlantic. However, the southern range limit of this species in the eastern South Atlantic near the Cape of Good Hope is uncertain because of possible joint occurrence of both sailfish species in that area, and the difficulty of separating these accurately in the field. The Atlantic sailfish is also known to migrate into the Mediterranean Sea, although the records from this area are few and mostly based on juvenile specimens. Furthermore, in at least one case (Ben-Tuvia, 1966) a specimen recorded from the Mediterranean as sailfish has been subsequently identified as Tetrapturus belone.

Habitat and Biology: This is an epipelagic and oceanic species, usually found in the upper layers of warm water above the thermocline (temperature range between 21° and 28°C), but also capable of descending to rather deep water. This is the least oceanic of the Atlantic billfishes, and it often migrates into near-shore waters. In the western Atlantic, it concentrates particularly in the Caribbean Sea, the Gulf of Mexico and around the West Indies and Florida. The distribution along the east coast of the USA appears to be influenced by meteorological conditions (wind) and by water temperatures; during summer, the fish move northward along with the extension of warm water, and with the beginning of cold weather and northerly winds they are driven back southward to congregate in schools off the Florida coast. In the eastern Atlantic, the shifts of the frontal zone of the Canaries Current and the Equatorial Countercurrent are responsible for the aggregation of the populations off West Africa; in spring the population in that area moves northward along the coast, and apparently returns toward the south in autumn, following the 28°C isotherm; the period of increased abundance off Ivory Coast coincides with the period of maximum surface water temperture, around 28°C.

I. albicans occasionally forms schools or smaller groups of 3 to 30 individuals, but more often occurs in loose aggregations over a wide area. Observations on the diel activity of this species off Florida have shown scattering of the population in the early morning, but by 09.00 hours schools of up to 30 individuals begin to form and feed on concentrations of small forage fish.

Mather et al. (1974) reported on the results of 18 years of billfish tagging under the Woods Hole Oceanographic Institution's Cooperative Gamefish Tagging Program; 12 525 sailfish were tagged and 97 recoveries recorded; the longest distance between the points of release and recovery was about 3 070 km, from off Cape Hatteras, North Carolina (USA) to off Guianas; the longest time at liberty of tagged fish was about 4 years.

The Atlantic sailfish is heterosexual, but there are no external morphological characters or colour to distinguish males and females; large fish are usually females. Around Florida, this species often moves inshore into shallow waters where the females, swimming sluggishly with their dorsal fins extended and accompanied each by one or more males, may spawn near the surface in the warm season (Voss, 1956; Jolley, 1977). However, Gehringer (1956), stated that spawning occurs in offshore waters beyond the 100 fathom isobath and appears to extend from April to September from south of Cuba to Carolina. In the eastern Atlantic, spawning has been observed in West African shelf waters throughout the year with a peak intensity during the summer months in the Conakry-St. Luis region, and from February to April in the Conakry-Freetown region (Ovchinnikov, 1970). Off southeast Florida, the presence of three distinct groups of maturing ovocytes in ripe ovaries reveals that ovocyte development is asynchronous, this resulting in fractional or multiple spawning; a 33.4 kg female may shed up to 4.8 million eggs in three batches during one spawning season (Jolley, 1977).

Although I. albicans probably competes for food with many other large pelagic fishes, such as other billfishes, tunas, sharks and dolphinfishes, it is most likely less affected by food competition than the other species. In the Atlantic it overlaps in geographical range and hence, competes for food during certain seasons of the year, particularly with Tetrapturus albidus and Makaira nigricans.

The food of larval Atlantic sailfish consists primarily of copepods, but the diet of the larvae changes rapidly to include predominantly fishes after an increase in size of only a few millimetres. Around Florida, adult I. albicans have been shown to feed mainly on pelagic fishes such as Euthynnus alletteratus, Hemiramphus spp., Trichiurus lepturus, Strongylura notatus, Caranx ruber, Lagodon rhomboides and squids, e.g., Argonauta argo, Ommastrephes bartrami, etc. They also often feed on bottom-dwelling organisms including sea robins (Triglidae), cephalopods and gastropods. This shows that I. albicans does not feed only in surface waters but also near the sea bottom down to considerable depths.

Size : This species reaches a maximum size beyond 3.15 m in total length and 58 kg in weight. The all-tackle angling record is a 58.10 kg fish taken off Luanda (Angola) on 27 March 1974. Other large records include individuals of 58 kg in 1975 and 52.75 kg in 1972 (both off Louanda) and 58 kg in 1979 from Cancun, Quintana Roo, Mexico (IGFA, 1981). The all-line-class world records recognized by IGFA are from West Africa (Angola and Senegal) and Mexico (Cancun, Quintana Roo). The largest fish recorded by sportsfishermen measured 3.15 m in total length and 55.8 kg weight (Walker Bay, Bahamas, 25 April 1950).

The majority of sportsfishing catches in southern Florida range from about 102 to 140 cm body length (or 173 to 229 cm total length) with considerable differences in weight (from 6.0 to 49.4 kg). The second largest size group ranges from 61 to 94 cm body length, averaging less than 6 kg in weight. The small fish begin to appear in the catches in late summer, becoming prominent in November, December and January. The body length of individuals caught by commercial tuna longliners in the Atlantic ranges from about 125 to 210 cm (mostly between 150 and 195 cm).

Interest to Fisheries : Catches of I. albicans in the period from 1978 to 1982 have been reported from five FAO major marine fishing areas (21, 31, 34, 41 and 47), mostly by Ghana, Japan, Brazil and the USSR. The total world catch was 267 metric tons in 1978, 2 823 t in 1979, 1 320 t in 1980, 1 091 t in 1981 and 920 t in 1982. More than 88% of the total catch from 1979 to 1982 was taken in Fishing Area 34 (eastern central Atlantic), predominantly by Ghana (FAO, 1984).

The principal commercial fishing gear for I. albicans is the tuna longline used primarily for tunas and marlins, and hence the Atlantic sailfish is a byproduct of the fisheries for these species. Trolling is the primary method used by sportsfishermen, mainly by towing baited hooks and lures through the surface water to stimulate swimming fish.

The flesh is good in summer, but usually not as good as that of marlins. It is marketed mostly frozen and often fresh in local markets.

Local Names : BRAZIL: Agulhão, Agulhão bandeira, Agulhão de vela, Agulhão vela, Bicudo, Guebuçú; CANADA: Sailfish; CUBA: Abanico, Aguja de abanico, Aguja voladora, Bicuda, Prieta, Voladeira; FRANCE: Voilier, Voilier de l'Atlantique; GHANA: Adzietekwesi, Fetiso, Onyankle; GOLD COAST: Fetiso; JAPAN: Nishibashoo, Nishibashookajiki (names for Atlantic sailfish landed in Japan); MEXICO: Pez vela, Volador; MOROCCO: Espadon; NETHERLANDS: Zegal-fisch; PORTUGAL: Bicuda, Espardarte veleiro, Peixe de vela, Veleiro, Veleiro do Atlantico; SENEGAL: Espadon, Oumbajhe; SPAIN: Pez vela, Pez vela del Atlántico; SOUTH AFRICA: Sailfish, Seilvis; UNITED KINGDOM: Sailfish; USA: Atlantic sailfish, Sail, Sailfish; USSR: Parusnik, Parusnik-ryba; VENEZUELA: Aguja vela; WEST INDIES: Balahoo, Billfish, Mère, Ocean gar, Sailfish, Squadron.

Literature : Voss (1953); de Sylva (1957); Cadenat (1961); Tinsley (1964); Wise & Davis (1973); Jolley (1974, 1977); Beardsley, Merrett & Richards (1975).

Remarks : Adults of I. albicans and I. platypterus are extremely similar and very difficult to distinguish. In the immature stage (to about 90 cm body length), this species has longer pectoral and caudal fins than I. platypterus; this seems to be due to the more rapid growth of I. albicans which attains a much smaller maximum size than I. platypterus. Further study is required to clarify the speciation problem of the two sailfish species. For the time being, the author prefers to retain the use of Istiophorus albicans (Latreille, 1804) for the Atlantic sailfish and Istiophorus platypterus (Shaw & Nodder, 1792) for the Indo-Pacific sailfish, but other research workers recognize a single species under the name Istiophorus platypterus.

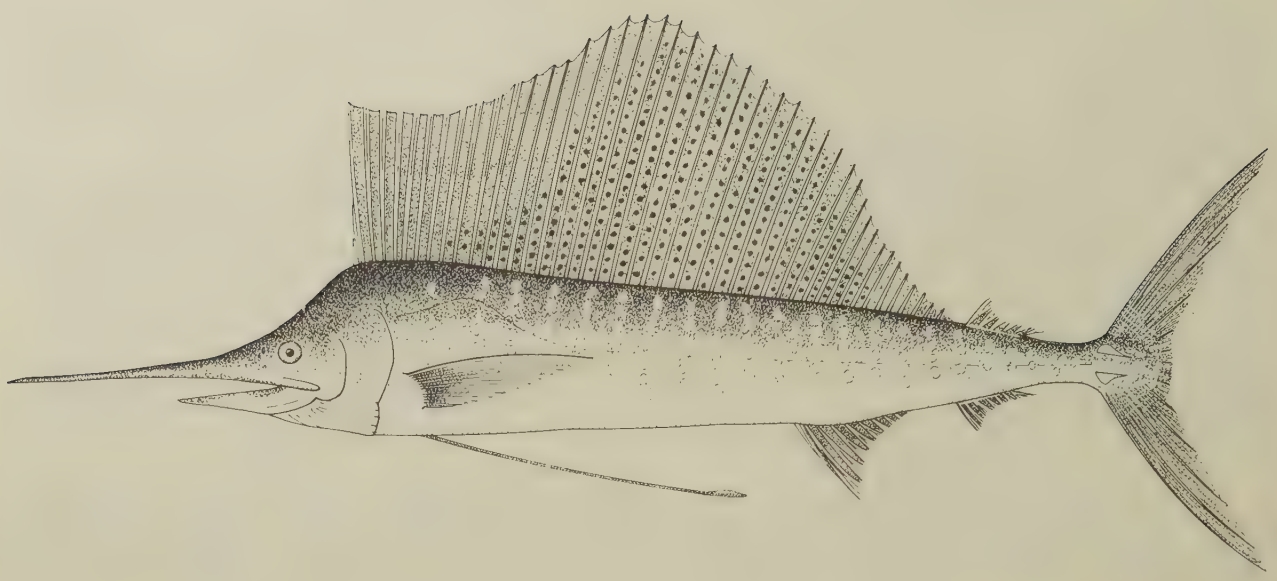
Istiophorus platypterus (Shaw & Nodder, 1792)

ISTIO Istio 2

Xiphias platypterus Shaw & Nodder, 1792, Nat.Misc., (28):no pagination, pl. 88 (Indian Ocean).

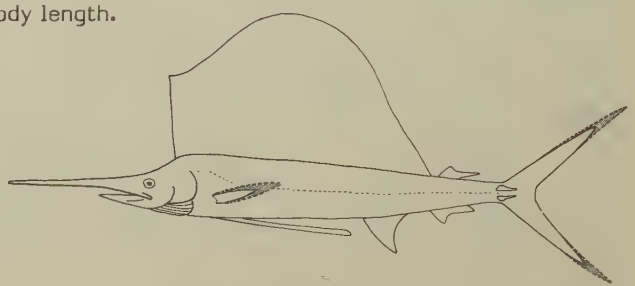
Synonymy : Scomber gladius Bloch, 1793; Istiophorus gladifer Lacepède, 1801; Xiphias velifer Schneider, in Bloch & Schneider, 1801; Histiophorus indicus Cuvier, in Cuvier & Valenciennes, 1832; Histiophorus immaculatus Rüppel, 1835; Histiophorus orientalis Schlegel in Temminck & Schlegel, 1842-50; Histiophorus gladius-Günther, 1860; Istiophorus dubius Bleeker, 1873; Istiophorus triactis Hemprich & Ehrenberg, 1899; Istiophorus japonicus Jordan & Thompson; Istiophorus gladius-McCulloch, 1921; Istiophorus orientalis-Jordan & Snyder, 1901; Istiophorus eriquius Jordan & Ball in Jordan & Evermann, 1926; Istiophorus Greyi Jordan & Evermann, 1926; Istiophorus greyi-Jordan, Evermann & Clark, 1930; Istiophorus brookei Fowler, 1933; Istiophorus ludibundus Whitley, 1933; Istiophorus immaculatus-La Monte & Marcy, 1941; Istiophorus amarui Curtis, 1944; Istiophorus gladius greyi-Nichols & Murphy, 1944; Istiophorus greyii-de Buen, 1958; Istiophorus platypterus-Whitehead, 1964.

FAO Names : En - Indo-Pacific sailfish; Fr - Voilier de l'Indo-Pacifique; Sp - Pez vela del Indo-Pacífico.

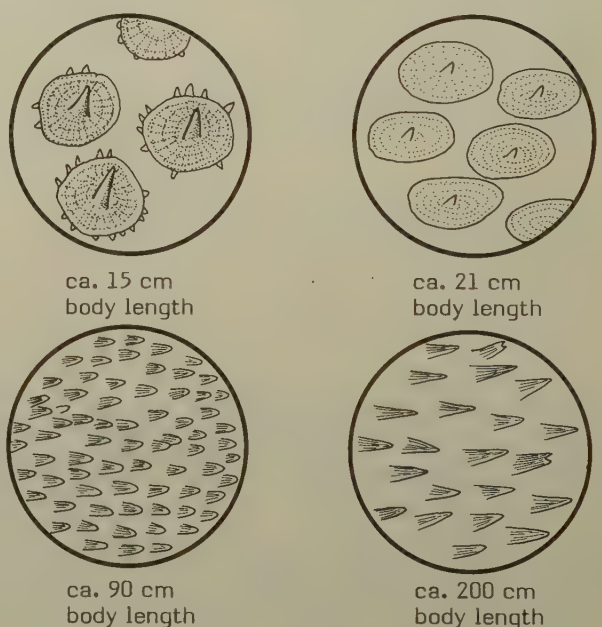


Field Marks : First dorsal fin sail-like and remarkably higher than greatest body depth; pelvic fins very long, nearly reaching to anus, with a well developed membrane. Pectoral and caudal fins short compared with those of Istiophorus albicans in young up to about 90 cm body length.

Diagnostic Features : Body fairly compressed. Bill long, slender and round in cross section; jaws and palatines with small, file-like teeth; no gillrakers; right and left branchiostegal membranes united to each other, free from isthmus. Two dorsal fins, the first large with 42 to 49 rays, the second small with 6 or 7 rays; first dorsal fin sail-like, with the middle rays longest, remarkably higher than body depth at level of midbody, its base long and close to that of second dorsal fin; two anal fins, the first with 12 to 17, the second with 6 or 7 rays; position of second anal fin slightly more forward than that of second dorsal fin; pectoral fins with 18 to 20 rays, relatively shorter than in I. albicans in immature specimens (to about 90 cm body length); pelvic fins extremely long, almost reaching to anus, depressible into a groove, with one spine and several soft rays fused tightly together and with a well developed membrane. Caudal peduncle with double keels on each side and a shallow notch on both, the dorsal and the ventral surfaces; anus situated near to first anal fin origin. Lateral line single and well visible. Scales varying in shape with growth; in adults they are somewhat sparse, imbedded in the skin, each with a single, rather blunt point, or with two posterior points. Vertebrae 24 (12 precaudal and 12 caudal). Colour: body dark blue dorsally, light blue splattered with brown laterally, and silvery white ventrally; about 20 rows of longitudinal stripes on sides, each stripe composed of many light blue round dots. Bases of first and second anal fins often tinged with silvery white; membrane of first dorsal fin dark blue or blackish blue, with scattered small, round black dots; remaining fins blackish brown or dark blue.



Immature of I. platypterus ca. 90 cm. body length
(screened areas show characters of I. albicans)



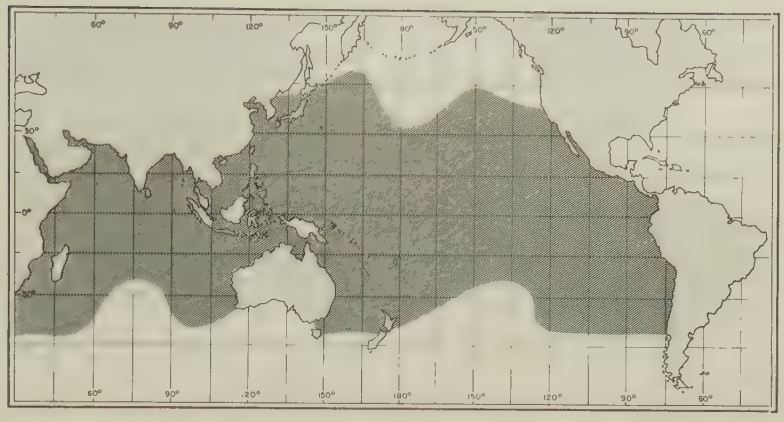
ca. 15 cm body length

ca. 21 cm body length

ca. 90 cm body length

ca. 200 cm body length

Schematic drawings of scales (not same size)



Geographical Distribution : I. platypterus is widely distributed in the tropical and temperate waters of the Pacific and Indian oceans. Its latitudinal range, based on data from longline catches, is approximately 45° to 50°N in the western North Pacific, 35°N in the eastern North Pacific, 40° to 35°S in the western South Pacific, 35°S in the eastern South Pacific, 45°S in the western Indian Ocean, and 35°S in the eastern Indian Ocean. This species shows a strong tendency to come close to the shore, even though a few individuals have been caught in the central parts of the oceans. Large numbers of Indo-Pacific sailfish are found in waters off Papua New Guinea, around the Solomon Islands, in the warm Kuroshio Current and its branch, the Tsushima Current, in the Sea of Japan, in the East China Sea, around the Philippines, in the Banda Sea, in the central South Pacific from Tahiti to the Marquesas, and off the Pacific coast of Mexico. They are also fairly abundant off the northern coast of Australia and around the Hawaiian Islands, India and Sri Lanka, but have been seldom seen off the Pacific coast of South America from Peru to Chile. This species has also entered the Mediterranean Sea from the Red Sea through the Suez Canal.

Habitat and Biology : The Indo-Pacific sailfish is an epipelagic and oceanic species, usually found above the thermocline. It shows a strong tendency to approach continental coasts, islands and reefs.

In the western Pacific, the distribution of postlarvae and adults appears to be closely related to the Kuroshio Current, and the densest concentrations seem to coincide with the spawning season. Individuals over 160 cm eye-fork length (= 84 to 88.7% of body length) migrate southward out of the East China Sea, presumably for spawning. In the eastern Pacific, the seasonal north-south displacements of this species off the coast of Mexico appear to coincide with the seasonal movements of the 28°C water isotherm. In the Indian Ocean, off East Africa, the abundance and distribution of I. platypterus is positively correlated with the months of the northeast monsoons when the East African Coastal Current reaches its maximum temperature (29° to 30°C) and minimum salinity (35.2 to 35.3°/oo). This is also the time of highest biological productivity in the surface waters caused by a mixing of waters resulting from the junction of the southward-flowing Somalia Current and the northward-flowing East African Coastal Current. In the Sea of Japan, considerable numbers of individuals of this species migrate in schools northward with the warm Tsushima Current (a branch of the Kuroshio) during summer (peak in later summer), and southward against the current during autumn (peak in early autumn), and are caught in these periods by the coastal setnets. These schools consist of young (55 to 110 cm body length) and adults (145 to 235 cm body length) with no fish of intermediate sizes caught by the setnets. Sometimes the young and the adults are mixed in the catches, but more often they are landed separately. Therefore, I. platypterus most likely schools by size. Usually, the young form more dense schools than the adults. In the East China Sea, the Indo-Pacific sailfish migrates northward in summer and returns southward in autumn where it overwinters in the southernmost area; fish under 160 cm eye-fork length move into the area between May and July while those over 160 cm migrate southward out of the area, probably for spawning.

Spawning of this species occurs with males and females swimming in pairs or with two or three males chasing a single female (probably mating behaviour). I. platypterus seems to spawn throughout the year in tropical and subtropical waters of the Pacific with peak spawning occurring in the respective local summer seasons. The ripe ovarian eggs are about 0.85 mm in diameter and have a single oil globule surrounded by a pale yellow indefinite nimbus; there are no structures on the vitelline membrane and the egg as a whole is transparent or translucent. Eggs shed from a captured female in the Indian Ocean averaged 1.304 mm in diameter.

The feeding behaviour of I. platypterus has been observed by fishermen as follows: when one or several sailfish found a school of prey fishes (sardines, anchovies, mackerels, or jack mackerels), they began to pursue it at half speed with their fins half- folded back into the grooves. They then drove at the prey at full speed with their fins completely folded back and once they had caught up with it, they suddenly made sharp turns with their fins expanded to confront a part of the school and then hit the prey with the bill. Subsequently they ate the killed and stunned fish, usually head first. Surprisingly, several individuals showed a kind of team-behaviour in capturing the prey.

I. platypterus and Makaira indica are the billfish species dominantly migrating into inshore waters and they undoubtedly compete with each other for food and habitat, although M. indica probably feeds on larger forage organisms, and swims a little deeper and farther offshore than the sailfish. The habitat of this species is strikingly different from that of the closely related Tetrapturus angustirostris which does not usually occur within 500 km off the coast, while M. indica is mostly distributed within this range.

The major forage items of the Indo-Pacific sailfish are fishes and squids, but the adults are fairly opportunistic feeders and take almost any food they come across. During several longline cruises of Japanese research vessels in the eastern North Pacific Ocean, adult I. platypterus have been shown to feed mainly on cephalopods and fishes (Bramidae, Stromateidae, Carangidae, Ostracion spp., Gempylidae, Auxis spp., Trachipterus spp., Belonidae, Balistidae, Coryphaena spp., Lagocephalus spp., etc.).

Large pelagic sharks, the killer whale and other related species attack billfishes and tunas hooked by longlines, but predation on free-swimming tunas and billfishes is thought to be very rare.

Size : This species reaches a maximum size beyond 340 cm in total length and 100 kg in weight. In the sports fishery (all tackle angling record) corresponds to a fish of 327.7 cm total length and 100.24 kg (221 lb) weight, taken at Santa Cruz Island, Galapagos, Ecuador on 12 February 1947. Another very large fish (340.4 cm total length and 89.81 kg (198 lb) weight) was taken at La Paz, Baja California, Mexico on 23 August 1957. Other records over 85 kg are the following: 90.26 kg (199 lb) at Pinas Bay, Panama on 17 January 1968; 89.81 kg (198 lb) at Mazatlan, Mexico on 10 November 1954; 87.54 kg (193 lb) at Acapulco, Mexico on 8 January 1978; 87.28 kg (192.7 lb) at Acapulco, Mexico on 4 October 1961; 87.09 kg (192 lb) at La Paz, Baja California, Mexico on 6 September 1950; and 85.72 kg (189 lb) at Yanuca, Fiji on 7 December 1967 (IGFA, 1981). All-line-class world records up to 1981 for both men and women recognized by IGFA are from the eastern Pacific, except the one for the women's 130-lb line class of 189 lb already mentioned from Yanuca, Fiji.

In sportsfishing at Malindi, Kenya, the majority of individuals caught ranged from 203 to 254 cm fork length (224 to 279 cm total length) and from 18.1 to 47.2 kg in weight. Length frequency data for sailfishes caught by longlines in the East China Sea, give size range from 105 to 240 cm body length (60% between 165 and 190 cm body length); the size distribution is essentially unimodal, except in June when a group of 125 to 150 cm fish suddenly appeared in the catch. Koto, Furukawa & Kodama (1959) believed that these small fish enter the East China Sea from other areas during this month. The average size of the individuals caught by longlines is unimodal, about 140 to 240 cm body length, while it is bimodal in those caught by driftnets and setnets, about 50 to 110 cm and 140 to 240 cm body length, respectively.

Interest to Fisheries : In the period from 1978 and 1982 catches of I. platypterus have been reported from seven FAO Fishing Areas (51, 57, 61, 71, 77, 81 and 87), predominantly by Japan and the Republic of Korea. The total world catch was 10 516 t in 1978, 7 916 t in 1979, 7 767 t in 1980, 6 438 t in 1981 and 7 214 t in 1982. Only 4% (285 t) of the 1982 total world catch were taken in the Indian Ocean, and 96% (6 929 t) in the Pacific Ocean, particularly in Fishing Areas 61 and 77 (northwest Pacific and eastern central Pacific) of which 6 218 t were taken by Japan, China (Taiwan Province) and the Republic of Korea. In Fishing Area 77 (eastern central Pacific), the Korean and Japanese landings have decreased remarkably in recent years: 5 425 t (1978), 4 351 t (1979), 1 525 t (1980), 539 t (1981) and 2 483 t (1982) (FAO, 1984). It should be noted that the catch statistics given for this species by Japanese longliners include Tetrapturus angustirostris, but that the share of the latter species in these catches is quite negligible.

Indo-Pacific sailfish are often taken as bycatch by the commercial surface tuna longliners. They are also caught by commercial fishermen with surface driftnets, and by trolling, harpooning and setnetting. In sportsfishing this species is caught by surface trolling.

The flesh is dark red, and not as good as that of marlins. In summer it is good for sashimi (sliced flesh with soy-sauce and horse radish) or sushi (vinegared boiled rice with sliced flesh and horse radish, dipped in soy-sauce during the meal).

Local Names : AUSTRALIA: Bayonet fish, Pacific sailfish, Sailfish; CHINA: Ho-soan-ki-hi, Tong-fang-chiyii, Yu-san-chi-yu, Yu-san-yu; COMOROS: Mbassi kouri; INDIA: Fung-hibaru, Mylmeen, Ola-meen, Peacock fish, Sailfish, Tadmasa, Yemungolah; INDONESIA: Djangilus, Geulang pajang, Hohoo malays, Ikan jegan, Ikan laya, Ikan layar, Lijarang, Landjareng, Lkajar plajaren, Panombuk, Stuji stuji; JAPAN: Akitaroo, Atsutaro, Banba, Baren, Barin, Bashoo, Bashookajiki, Byoobu, Byoobusashi, Haio, Haioshibi, Haou, Hauo, Kanga, Kannushi, Koomori, Minokajiki, Nourage, Oba, Suginairage, Suginairagi, Sugiyama, Tobihira; KENYA: Mbassi, Nsulinsuli; MADAGASCAR: Ndwaro; MALAYSIA: Mersuji, Layeran; MEXICO: Pez vela, Volador; NEW CALEDONIA: Empéreur éventail, Voilier; PHILIPPINES: Dogso, Dugso, Dumosok, Kandelan, Kandayan, Liplipan, Malasugi, Sailfin, Sailfish; REPUBLIC OF KOREA: Dot-sae-chi; SRI LANKA: Mylmeen, Thalapatha; TAHITI: Haurepe; TANZANIA: Mbassi, Nsuli nsuli; USA: Pacific sailfish, Sailfish; USSR: Parusnik, Parusnik-ryba; VIET NAM: Cá co.

Literature : Nakamura, H. (1937, 1938, 1940, 1942, 1949, 1951); Koto, Furukawa & Kodama (1959); Koto & Kodama (1962); Ueyanagi (1963, 1963a, 1964); Tinsley (1964); Williams (1964, 1970); Kume & Joseph (1969, 1969a); Nakamura, I. (1974, 1983); Beardsley, Merrett & Richards (1975).

Remarks : See remarks for Istiophorus albicans.

Makaira Lacepède, 1802

ISTIO Mak

Genus : Makaira Lacepède, 1802. Histoire naturelle des poissons, 1802, 4:688-95, pl.13 (fig.3).

Type Species : Makaira nigricans Lacepède, 1802.

Synonymy : Machaera Cuvier, 1832 (amended spelling); Macaira Nardo, 1833 (amended spelling); Istiompax Whitley, 1931; Marlina Hirasaka & Nakamura, 1947; Eumakaira Hirasaka & Nakamura, 1947; Orthocraeros Smith, 1956; Istiomax Abe, 1963 (?missprint).

Remarks : There have been different opinions regarding the species composition of this genus (see discussion on page 35).

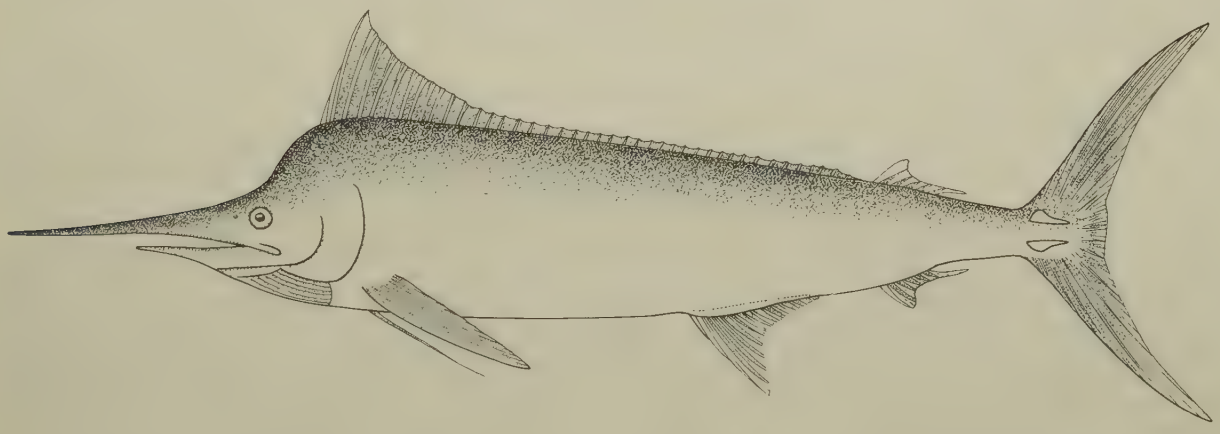
Makaira indica (Cuvier, 1832)

ISTIO Mak 2

Tetrapturus indicus Cuvier, in Cuvier & Valenciennes, 1832, Histoire Naturelle des Poissons, 8:209-10 (Sumatra, Indonesia).

Synonymy : Tetrapturus australis Macleay, 1854; Histiophorus brevirostris Playfair, in Playfair & Günther, 1866; Tetrapturus brevirostris-Goode, 1882; Makaira marlina Jordan & Hill, in Jordan & Evermann, 1926; Makaira indica-Jordan & Evermann, 1926; Istiompax australis-Whitley, 1931; Makaira indicus-Deraniyagala, 1933; Makaira australis-Fowler, 1934; Makaira nigricans marlina-Nichols & LaMonte, 1935; Makaira nigricans tahitiensis Nichols & LaMonte,1935; Makaira brevirostris-LaMonte & Marcy, 1941; Makaira ampla marlina-LaMonte & Marcy, 1941; Makaira ampla tahitiensis-LaMonte & Marcy, 1941; Marlina marlina-Hirasaka & Nakamura, 1947; Malina malina-Chen, 1951; Makaira marhina-Mori, 1952; Istiompax dombraini Whitley, 1954; Makaira marhina-Chyung, 1954; Makaira mazara tahitiensis-LaMonte, 1955; Makaira xantholineatus Deraniyagala, 1956; Makaira herscheri-Fourmanoir, 1957; Makaira marlina marlina-Morrow, 1957; Makaira marlina tahitiensis-Morrow, 1957; Istiompax marlina-Royce, 1957; Istiompax brevirostris-Morrow, 1958; Istiompax indicus-Morrow, 1959; Makaira (Istiompax) indica-Robins & de Sylva, 1961; Istiomax indicus-Abe, 1963.

FAO Names : En - Black marlin; Fr - Makaire noir; Sp - Aguja negra.



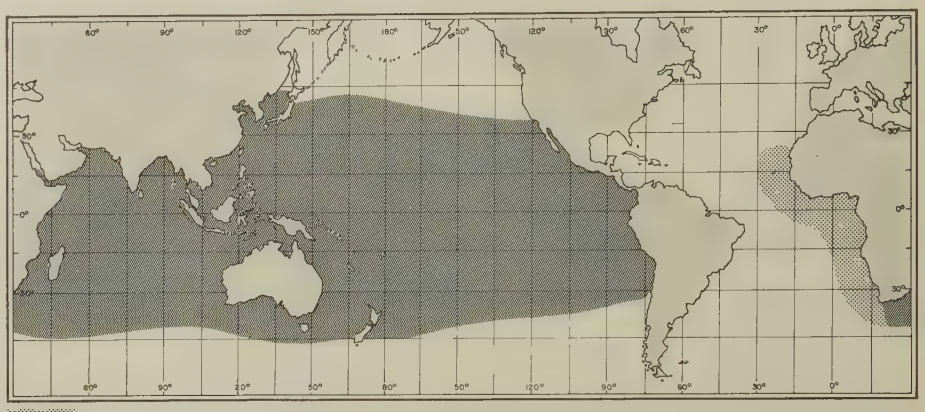
Field Marks : Body not very compressed; nape highly elevated; height of anterior lobe of first dorsal fin smaller than greatest body depth; second dorsal fin slightly forward of second anal fin; pectoral fins rigid, not adpressible against sides of body.

Diagnostic Features : Body not strongly compressed. Bill long, extremely stout, and round in cross section; nape conspicuously elevated; right and left branchiostegal membranes completely united to each other, but free from isthmus; no gillrakers; both jaws and palatines (roof of mouth) with small, file-like teeth. Two dorsal fins, the first with 34 to 43 rays, low (anterior lobe lower than body depth); with a long base ending close to second dorsal fin origin; second dorsal fin with 5 to 7 rays, its position slightly forward with respect to that of second anal fin; two anal fins, the first with 10 to 14 and the second with 6 or 7 rays; pectoral fins with 12 to 20 rays, rigid, not adpressible to sides of body; pelvic fins with a poorly developed membrane, shorter than the pectorals and depressible into ventral grooves. Caudal peduncle fairly

scales

compressed (laterally) and slightly depressed (dorso-ventrally), with strong double keels on each side and a poorly developed notch on both, the dorsal and ventral surfaces; anus situated near first anal fin origin. Lateral line single but obscured, especially in larger fish. Body densely covered with thick, elongate bony scales, each with 1 or 2 (mostly 1) sharp posterior points. Vertebrae 24 (11 precaudal and 13 caudal). Colour: body dark blue dorsally and silvery white ventrally; usually no blotches or dark stripes on body in adults, although light blue vertical stripes may occur in a few fish. First dorsal fin blackish to dark blue; other fins usually dark brown, sometimes tinged with dark blue.

Geographical Distribution : The black marlin is distributed throughout the tropical and subtropical waters of the Pacific and Indian oceans where the main population and the spawning grounds occur, but it occasionally also enters temperate waters. Stray individuals have been found to migrate into the Atlantic Ocean by way of the Cape of Good Hope, but the existence of Atlantic breeding stocks is unlikely. The latitudinal range of this species, based on Japanese commercial long-liners' catches extends northward to 35°-40°N in the North Pacific and southward to 45°S in the western Pacific and 30°-35°S in the eastern Pacific, and northward to 25°N and southward to 45°S in the Indian Ocean.



Area of occasional distribution, or invasion, (no spawning)

Habitat and Biology : This is an epipelagic and oceanic species usually found in surface waters above the thermocline at temperatures ranging from 15° to 30°C, often in nearshore waters close to land masses, islands, and coral reef areas. In tropical oceanic areas its distribution is continuous, although rather scattered, whereas its presence in temperate waters is occasional.

M. indica usually occurs nearer to the surface than most other billfishes (except the sailfish), but this is by no means a general rule. The commercial longline fishery generally operates in waters deeper than 100 m, and in the equatorial western Indian Ocean, peak catch rates of black marlin have been reported to occur in the upper water layers (0 to 200 m) over depths of 365 to 915 m (200 to 500 fathoms).

Like other billfishes, the black marlin effects seasonal migrations. In the East China Sea, schools of this species move northward during spring and summer and southward during autumn and winter. In the Sea of Japan, the north-bound migration occurs in late summer and early autumn following the core of the Tsushima Current (a warm branch of the Kuroshio Current), and the return to southern waters takes place in autumn, with the fish swimming against the current.

The sexes are separate in M. indica, but males and females are indistinguishable by external features. In the waters around Taiwan Island, the sex ratio was found to be 53/414 males in fish ranging from 20 to 200 kg weight. As in other marlins, females become larger than males. M. indica is densely distributed in the northwestern part of the Coral Sea between October and December. Almost all fish caught at that time in this area have well-developed gonads, and are therefore believed to belong to spawning schools. The skewed sex ratio (541/615 females) may also be indicative of this possibility. Sportsfishermen from Cairns, Queensland (Australia) eyewitnessed what might be the courtship behaviour of the black marlin: a group composed of one large fish (supposed to be female) followed by several smaller fish (supposed to be males) was seen swimming on an undulating course, sometimes back and forth, the fish being closer together than is usual in the shallow coral reef areas near Cairns.

On the basis of records of the presence of larvae and mature females, spawning is believed to occur in the vicinity of Hainan Island and in the South China Sea in May and June, around Taiwan Island from August to October, in the northwestern part of the Coral Sea between October and December, and off Cairns (Australia) from August to November. Black marlin are believed to prefer water temperatures around 27° to 28°C during spawning. Egg counts of ripe roe totalled about 40 million per female.

Black marlins use their long and stout bill for feeding. Analyses of stomach contents show that the prey is usually swallowed head first and bears slashes that had obviously been inflicted by the predator's bill. The prey includes skipjack (Katsuwonus pelamis), yellowfin tuna (Thunnus albacares), bigeye tuna (Thunnus obesus), frigate tunas (Auxis species) and other tuna species. The feeding habits of M. indica vary from area to area and by seasons. In Pacific equatorial waters, food items include mainly Scombridae, Gempylidae, Coryphaenidae, Xiphiidae and Carangidae, squids and cuttlefishes, while other groups, i.e., Sternoptychidae, Paralepididae, Alepisauridae, Chiasmodontidae, Chaetodontidae, Balistidae, Ostraciidae and Tetraodontidae, octopods and large decapod crustaceans are of lesser importance.

The larvae and juveniles of the black marlin are predated upon by pelagic carnivorous fishes such as large sharks, scombrids, carangids, dolphinfishes and other billfishes. There are no true predators of the adults except for the killer whale (Orcinus orca) and related species (only a few cases known). The main food competitors for the black marlin are thought to be large sharks, swordfish, large tunas and other marlins.

Size : This species reaches sizes beyond 448 cm in total length and 700 kg in weight. The heaviest record of black marlin in sportsfishing (the all tackle angling record) is a specimen of 442 cm (body length) and 707.61 kg weight, caught at Cabo Blanco, Peru, on 4 August 1953. Considerable numbers of black marlin weighing in excess of 500 kg are often caught off Cairns, Queensland, Australia. The measurements taken of the two female black marlins in excess of 1 000 lb caught during the First International Black Marlin Tournament held at Cairns, in October 1973, were 448 cm total length (481.4 kg) and 437.2 cm total length (484.3 kg). Other examples of gamefishing records are specimens of 426.7 cm total length (509.8 kg), 436.9 cm total length (691.7 kg) and 447 cm total length (552.5 kg).

The size range of black marlin taken by commercial longline fisheries is 150 to 310 cm (mostly 170 to 210 cm) body length in the western Indian Ocean and 170 to 310 cm (mostly 185 to 240 cm) body length in the Coral Sea.

Interest to Fisheries : There are important longlining, harpooning, trolling and setnet fisheries for M. indica in the Pacific as well as in the Indian Ocean. Catches are reported from five FAO Fishing Areas (51, 57, 61, 77 and 81) by various nations. The world catch was 2 909 t in 1978, 3 440 metric tons in 1979, 2 465 t in 1980, 2 453 t in 1981 and 2 373 t in 1982. About 80 to 90% of this catch was taken by Chinese (Taiwan Province) vessels in Fishing Area 61 (northwestern Pacific), amounting to 2 591 t (89%) in 1978, 3 183 t (93%) in 1979, 1 991 t (81%) in 1980, 1 981 t (81%) in 1981 and 2 416 t (91%) in 1982 (FAO, 1984). In addition, it is estimated that Japan and the Republic of Korea, though excluded from FAO statistics, are currently catching about 2 000 t of this species in Fishing Area 61.

M. indica is mostly caught by ordinary surface tuna longliners. These vessels vary considerably in size, the largest being about 2 000 GRT mother ships with several small catch boats on either side of the deck (this type of ship stopped operating recently), but the majority are between 250 and 350 GRT, as this size appears to be the most economical and efficient. Longlining vessels larger than 100 GRT are usually made of steel, while the smaller boats are mostly wooden.

Harpoon-fishing is carried out on the fishing grounds off Taiwan Island and southern Japan. Small (about 10 m long) wooden, engine-powered boats are used in this activity. Optimum temperatures for harpoon-fishing for this species range from 23° to 25°C (westward of Uotsurijima, in the East China Sea, between October and April).

Sportfishering off northeastern Australia, Peru and Ecuador is usually carried out from ordinary trolling boats (36 to 42 feet long with inboard engines). In these areas, black marlins are more dominant among big game fishes than on other sportsfishing grounds.

Finally, black marlins are also often taken by setnets displayed to catch the "yellowtail", (Seriola quinqueradiata) in southern and western Japan during summer and autumn.

Good fishing grounds for black marlin (shallower than those of other billfishes) are found in the East China Sea in the area where the Kuroshio and Tsushima currents mix with the waters of the Yellow Sea. The fishing season extends from July to January (peak between August and October) between 30° and 34°N; from May to July and from October to April (peaks in June and July and October and January, respectively), between 25° and 30°N, and throughout the year around Taiwan Island (peak between October and December in the South China Sea and in February and March off eastern Taiwan Island). Juvenile and young black marlin migrate in schools in July and August, and in the coral reef areas of northern Queensland, adults come near the shore between September and November.

Data on fishing effort and intensity are insufficient in all of the above areas. However, it is known that most of the fishing effort and intensity are displayed in the East China Sea, the waters around Taiwan Island, off northwestern Australia, in the Coral Sea, Arafura Sea, Sulu Sea, Celebes Sea and northwestern Arabian Sea.

Local Names : AUSTRALIA: Black marlin; CHINA: Kyau-shit-á, Lih-ch'ih-Ch'i-yü; JAPAN: Genba, Katahari, Shiro, Shiroka, Shirokajiki, Shirokawa, Shirokawajiki, Shiromazaara, Shiruachi; NEW ZEALAND: Black marlin; PAPUA NEW GUINEA: Black marlin; REPUBLIC OF KOREA: Baek-sae-chi; SRI LANKA: Ahin koppara, Kopparaikulla, Kopparan, Kopparava, Makara, Marlin, Saparava; USA: Black marlin, Giant black marlin, Pacific black marlin, Silver marlin; USSR: Sere bristyi marlin.

Literature : Howard & Ueyanagi (1965); Ueyanagi (1960); Merrett (1971); Nakamura (1975, 1983); Goadby (1972); Howard & Starck (1975); Mather (1976).

Remarks : The English common name "black marlin" had not been universally accepted for Makaira indica until the midsixties. Prior to this agreement, many authors, particularly Japanese, called this species "white marlin" which is a direct translation from the Japanese common name, "Shirokajiki" (shiro = white, kajiki = marlin) The general colour of this species is black or blueblack while alive, but after death it changes to white and this seems to be the cause of the above-mentioned nomenclatorial discrepancy.

Makaira mazara (Jordan & Snyder, 1901)

ISTIO Mak 3

Tetrapturus mazara Jordan & Snyder, 1901, J.Coll.Sci.Imp.Univ.Tokyo, 15(2):305 (Japan).

Synonymy : Makaira mazara Jordan & Evermann, 1926; Makaira ampla mazara-LaMonte, 1941; Makaira nigricans-Fowler, 1944 (many authors erroneously use the name Makaira nigricans for this species); Eumakaira nigra Hirasaka & Nakamura, 1947; Makaira nigricans mazara-Rosa, 1950; Istiompax howardi Whitley, 1954; Istiompax mazara-Whitley, 1968; Makaira nigra-Abe, 1957; Makaira (Makaira) nigricans-Robins & de Sylva, 1961.

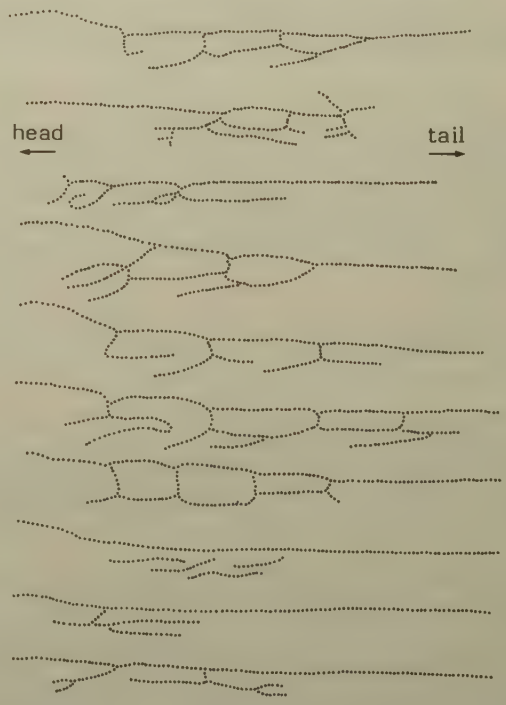
FAO Names : En - Indo-Pacific blue marlin; Fr - Makaire bleu de l'Indo-Pacifique; Sp - Aguja azul del Indo-Pacífico

Field Marks : Body not very compressed; nape highly elevated; height of anterior lobe of first dorsal fin less than greatest body depth; lateral line system with simple loops.

Diagnostic Features : Body not strongly compressed. Bill long, extremely stout and round in cross section; nape conspicuously elevated; right and left branchiostegal membranes completely united to each other, but free from isthmus; no gillrakers; both jaws and palatines (roof of mouth) with small, file-like teeth. Two dorsal fins, the first with 40 to 45 rays, lower than body depth throughout its length, with a pointed anterior lobe and a long base, originating above the posterior margin of preopercle and ending close to the second dorsal fin origin; second dorsal fin with 6 or 7 rays, its position slightly backward with respect to that of second anal fin; two anal fins, the first with 12 to 17 rays and the second with 6 or 7 rays; pectoral fins long and narrow, adpressible to sides of body, with 20 to 23 rays; pelvic fins shorter than the pectorals, with a poorly developed membrane and depressible into deep ventral grooves. Caudal peduncle fairly compressed (laterally) and slightly depressed (dorsoventrally), with strong double keels on each side and a shallow notch on both the dorsal and ventral surfaces; anus situated near first anal fin origin. Lateral line single, following a single loop pattern, obvious in juveniles and immature fish, but obscure in adults, as it becomes progressively imbedded in the skin with growth (however, the line becomes always clearly visible when the epidermis is removed). Body densely covered with elongate, thick, bony scales, each with usually 1 or 2, sometimes with 3 posterior points. Vertebrae 24 (11 precaudal and 13 caudal). Colour: body blue-black dorsally and silvery white ventrally, with about 15 rows of

ca. 17 cm. body length ca. 170 cm. body length

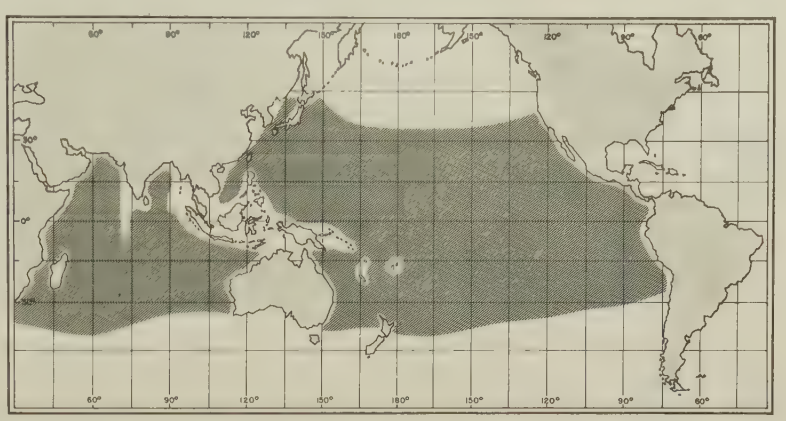
Schematic drawings of scales (not same size)



Lateral line systems of left side in size growth (schematic)

pale, cobalt-coloured stripes, each consisting of round dots and/or narrow bars (these stripes may not always be visible, especially in long-preserved specimens). First dorsal fin blackish or dark blue, other fins blackish brown, sometimes tinged with dark blue; bases of first and second anal fins tinged with silvery white.

Geographical Distribution: The Indo-Pacific blue marlin is found primarily in the tropical and subtropical waters of the Pacific and Indian oceans. It is the most tropical billfish species and is frequent in equatorial waters. Its latitudinal range, based on data from the commercial longline fishery, extends to about 45°N in the western North Pacific Ocean, 35°N in the eastern North Pacific, 35°S in the western South Pacific, 25°S in the eastern South Pacific, 40 to 45°S in the southwestern Indian Ocean and 35°S in the southeastern Indian Ocean.



Habitat and Biology: This is an epipelagic and oceanic species mostly confined to the waters on the warmer-side of the 24°C surface isotherm and known to effect seasonal north-south migrations. Pacific blue marlins are not usually seen close to land masses or islands, unless there is a deep drop-off of the shelf (900 to 1 800 m as in the waters off Kailna-Kona, Hawaii Island).

The monthly distribution of catches by Japanese longliners shows two main seasonal concentrations of M. mazara: one from December through March in the western and central South Pacific between 8° and 26°S, and the other from May through October in the western and central North Pacific between 2° and 24°N. In the remaining two months (April and November) the fish tend to concentrate in the equatorial Pacific between 10°N and 10°S. This species becomes less abundant toward the eastern Pacific; in the Indian Ocean, it is known to be relatively abundant around Sri Lanka and Mauritius; off the east coast of Africa, it is apparently abundant between the equator and 13°S during the southeast monsoon period (from April to October).

In Hawaiian waters, an ecological interaction is known between M. mazara and the striped marlin, Tetrapturus audax, with the two species responding in different, respectively exclusive ways, to certain environmental factors such as temperature or food.

Of 170 individuals of M. mazara tagged from 1963 through 1970 in the Pacific Ocean, no recoveries were made up to 1972. Five specimens were tagged with ultrasonic transmitters and tracked off Hawaii in 1971 and 1972. A fish of 270 kg was successfully tagged and tracked on 14 and 15 July 1971, 3.1 miles west of Keauhou, Hawaii Island (Yuen, Dizon & Uchiyama, 1974). The tag was inserted on 14 July at 09:35 hours and the fish was tracked by the R.V. CHARLES H. GILBERT until 08.00 hours of the next morning. A temperature-sensitive tag was used on this occasion for the purpose of obtaining information on depth. During the tracking period, the fish moved to about 25 miles north of the point of release on an erratic course cruising between the 183 m and 1 830 m (100 and 1 000 fathom) isobaths. The calculated speed of the fish ranged from 0.6 to 4.4 knots (0.09 to 0.62 body length/sec) with an average of 1.6 knots (0.23 body length/sec). Swimming depth varied from the surface to 73 m, but the fish remained mostly within the upper 37 m.

Larvae of M. mazara have been extensively collected in the tropical and subtropical waters of the western and central Pacific Ocean, and south of the Maldive Islands, around the Mascalene Islands, and off the south coasts of Java and Sumatra in the Indian Ocean. Ripe eggs in the ovary are transparent with a yellow oil globule, and measure about 0.8 to 0.9 mm in diameter.

This species is believed by commercial fishermen to form small-scale schools consisting of at most ten individuals. Larger fish tend to swim solitary.

M. mazara is known to feed in and near surface waters, but sometimes takes food in relatively deep waters as is suggested by the finding of the deep-dwelling squirrel fish (Holocentrus laeteoguttatus) in the stomachs of this species off Hawaii. The feeding behaviour has been observed by a fishery biologist off Baja California: after a fish of about 3 m body length had found a school of squids (Dosidicus gigas measuring about 40 cm mantle length) that was gathering under the night-light of a squid-fishing boat, it approached the school at almost full speed with its fins completely held back in the grooves, then suddenly hit the squids with its bill, subsequently nudging the stunned prey and eating it head first. This species has also been observed to swallow big tunas like skipjack (Katsuwonus pelamis), yellowfin tuna (Thunnus albacares) and bigeye tuna (Thunnus obesus) head first, and the fishes found in stomachs of M. mazara often showed deep slashes on their bodies, presumably caused by the bill of the marlin. These observations show that this species seems to use its bill quite often for feeding.

Stomachs of M. mazara contained mostly squids (Philippine Sea), and tuna-like fishes (off New Zealand and in the central Pacific). In Hawaiian waters, tuna-like fishes make up more than 85% in volume of the Indo-Pacific blue marlin's diet. A large individual caught off Hawaii had a 29 kg bigeye tuna in its stomach and its weight, including the bigeye, was 340 kg. In the eastern North Pacific, M. mazara has been shown (from the results of Japanese longline research cruises) to feed primarily on squids and fishes, in particular Bramidae, Carangidae, Gempylidae, Auxis spp., Xiphias gladius, etc.

Dr Radtke estimated the age of this species based on otolith readings (Pacific Gamefish Research News, 1982) as follows: (1) Males: 52.1 kg=6 years; 68.3 to 71.2 kg=7 to 8 years; 82 kg=9 years; 96.9 to 114.2 kg=11 to 12 years; (2) Females: 135.4 to 147.4 kg=8 years; 209.2 to 228.8 kg=13 to 15 years; 286.3 kg=16 years, 336.5 kg=17 years.

Large pelagic sharks like Isurus, Prionace, Lamna and Carcharhinus, as well as the killer whale (Orcinus orca) and related species have often been observed to attack tunas and billfishes (including this species) hooked on longlines. The author believes that such attacks are highly improbable under natural conditions.

Size : M. mazara attains sizes over 906 kg (2 000 lb) in commercial longline fisheries and to about 820 kg in sportsfishing activities. The heaviest record in sportsfishing (unofficial data, since more than one person was on the fishing rod) is the 818 kg (1 805 lb) "Choys monster" caught by Captain Cornelius Choy and his party off Waikiki, Hawaii; the second-largest is a specimen of 447 cm total length, 523 kg (1 153 lb) weight, and 185 cm of girth caught at Ritidian Point in Guam (this is the all tackle angling record). The heaviest record listed in "World Record Game Fishes, 1982" published by the International Game Fish Association is a fish of 498.95 kg (1 100 lb) weight, 420.4 cm total length, and 200 cm girth width from Le Morne, Mauritius. The size range of M. mazara caught by commercial longliners averages approximately 200 to 285 cm body length in Pacific equatorial waters and 215 to 300 cm body length in the Indian Ocean.

In the Pacific, size at first maturity of males is thought to range from 130 to 140 cm eye-fork length (86.8 to 87.8% of body length). Females attain larger sizes than males; around the Bonin-Islands, fish over 200 cm eye-fork length are all females; around Taiwan Island males attain less than 120 kg weight, while females grow to over 300 kg.

Interest to Fisheries : Catches of M. mazara have been reported by about 10 countries from seven FAO Fishing Areas (51, 57, 61, 71, 77, 81 and 87). The major fishing nations in the period from 1978 to 1982 were Japan and the Republic of Korea. The total world catch was 18 193 t in 1978, 18 654 t in 1979, 21 109 t in 1980, 21 413 t in 1981 and 20 727 t in 1982. Only 8.2% (1 761 t) of the 1981 catch came from the Indian Ocean, while 91.8% (19 652 t) were taken in the Pacific Ocean, particularly in Fishing Area 61, northwest Pacific (7 543 t), by Japanese and Chinese (Taiwan Province) vessels (about equal shares); in Fishing Area 71, western central Pacific (6 048 t) by Japan, Malaysia, the Philippines and the Republic of Korea; and in Fishing Area 77, eastern central Pacific (4 979 t) by Japan and the Republic of Korea. In 1982, 8.3% of the total catch were taken in the Indian Ocean, while 91.7% came from the Pacific Ocean, particularly from Fishing Areas 61, 71 and 77 (FAO, 1984).

The gear most commonly used for fishing M. mazara is the Japanese type of longline and its derivates, but this species is most often caught incidental to fisheries directed at other marlins (M. indica and Tetrapturus audax) and tunas (Thunnus thynnus, Thunnus obesus and Thunnus albacares). Most Japanese tuna longline vessels range in size from 240 to 340 GRT. Recently, many of them have been equipped with freezing facilities capable of preserving the fish in excellent condition at very low temperatures, between -40° and -50°C or at even lower temperatures in the most modern vessels. M. mazara is also taken incidentally by harpooning boats aiming at Makaira indica, Tetrapturus audax or Xiphias gladius around southern Japan and Taiwan Island.

The quality of the flesh is excellent for sashimi (sliced raw fresh flesh with soy-sauce and horse radish). Most of it is marketed frozen.

Local Names : AUSTRALIA: Blue marlin; CHILE: Pez zuncho; CHINA: Lan fu yii; JAPAN: Aburakajiki, Genba, Katokui, Katsuokui, Kudamaki, Kuro, Kuroka, Kurokajiki, Kurokawa, Kurokawakajiki, Kuromazaara, Mazaara, Njiachi, Njiara, Tsun; MALAYSIA: Mersudji; MEXICO: Marlín azul, Marlín negro; NEW CALEDONIA: Empéreur, Marlin bleu; NEW ZEALAND: Marlin, Taketonga; REPUBLIC OF KOREA: Nok-sae-chi; TAHITI: Haura; USA: Blue marlin, Cuban black marlin; USSR: Ch'joernij marlin; VIET NAM: Cá cè' den.

Literature : Nakamura, H. (1938, 1942); Royce (1957); Ueyanagi (1964); Howard & Ueyanagi (1965); Nakamura, Iwai & Matsubara (1968); Strasburg (1969, 1970); Merrett (1971); Nakamura, I. (1974, 1983); Howard & Starck (1975).

Remarks : The English name "black marlin" was often used among Japanese scientists for Makaira mazara until the mid-sixties. "Black marlin" is a direct translation of the Japanese common name, "Kurokajiki" (kuro = black, kajiki = marlin) for this species. See also "Remarks" under Makaira nigricans.

Makaira nigricans Lacepede, 1802

ISTIO Mak 1

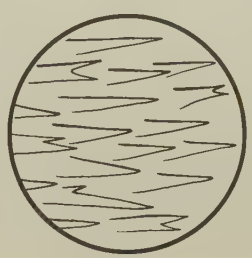
Makaira nigricans Lacepède, 1802, Histoire naturelle des Poissons, 4:688-91, pl. 12 (Fig. 3). Ile de Re, Bay of Biscay).

Synonymy : Tetrapturus herschelii Gray, 1838; Histiophorus herschelii-Günther, 1860; Tetrapturus amplus Poey, 1860; Tetrapturus Herschelii-Lütken, 1880; Makaira herscheli-Jordan & Evermann, 1896; Makaira ampla-Jordan & Evermann, 1926; Makaira ensis Jordan & Evermann, 1926; Makaira bermudae Mowbray, 1931; Makaira nigricans nigricans-Nichols & LaMonte, 1935; Makaira nigricans ampla-Nichols & LaMonte, 1935; Makaira ampla ampla-LaMonte & Marcy, 1941; Makaira perezi deBuen, 1950; Orthocraeros bermudae-Smith, 1956; Makaira herschelii-Smith, 1956; Makaira (Makaira) nigricans-Robins & deSylva.

FAO Names : En - Atlantic blue marlin; Fr - Makaire bleu de l'Atlantique; Sp - Aguja azul del Atlántico.

Field Marks : Body not very compressed; nape highly elevated; height of anterior lobe of first dorsal fin less than greatest body depth; lateral line system chickenwire-shaped.

Diagnostic Features : Body not strongly compressed. Bill long, very stout and round in cross section; nape conspicuously elevated; right and left branchiostegal membranes completely united to each other, but free from isthmus; no gillrakers; both jaws and palatines (roof of mouth) with small, file-like teeth. Two dorsal fins, the first with 39 to 43 rays, lower than maximum body depth throughout its length, with a pointed anterior lobe and a long base, originating above the posterior margin of preopercle and ending near second dorsal fin origin; second dorsal fin with 6 or 7 rays, its position slightly backward with respect to that of second anal fin; two anal fins, the first with 13 to 16, the second with 6 or 7 rays, and very similar in size and shape to the second dorsal; pectoral fins long and narrow, adpressible to sides of body, with 19 to 22 rays; pelvic fins shorter than the pectorals, with a poorly developed membrane, and depressible into deep ventral grooves. Caudal peduncle fairly compressed (laterally) and slightly depressed (dorsoventrally), with strong double keels on each side and a poorly developed notch on both the dorsal and ventral surfaces; anus situated just in front of first anal fin origin. Lateral line forming a complicated network pattern, obvious in immature fish but obscure in adults, as it becomes progressively imbedded in the skin (however, the line becomes always clearly visible when the epidermis is removed). Body densely covered with elongate, thick, bony scales, each with usually 1 or 2 (mostly 1), sometimes with 3 posterior points. Vertebrae 24 (11 precaudal and 13 caudal). Colour: body blue-black dorsally and silvery white ventrally, with about 15 rows of pale cobalt-coloured stripes, each consisting of round dots and/or narrow bars. First dorsal fin membrane blackish or dark blue, without any dots or marks, other fins usually brown black, sometimes tinged with dark blue; bases of first and second anal fins tinged with silvery white.



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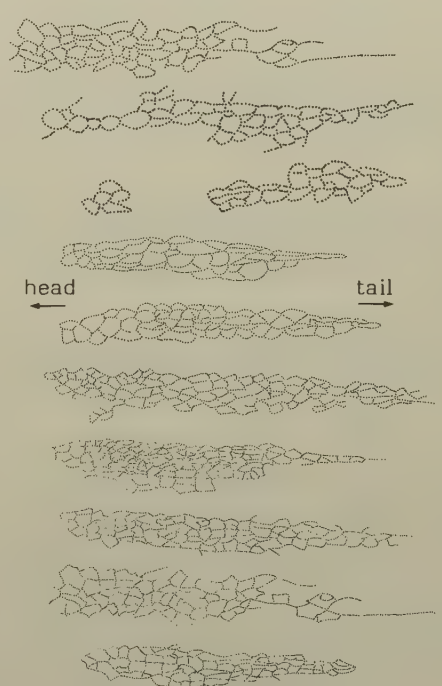


Lateral line systems of left side in size growth
(schematic)

Geographical Distribution: This species is distributed mainly in the tropical and temperate waters of the Atlantic. It is the most tropical of all Atlantic billfishes and probably more abundant in the western than in the eastern Atlantic, judging from the hook rates attained by commercial fisheries in both areas. Its latitudinal range, based on data from the commercial longline fishery, extends from about 40° to 45°N in the North Atlantic to 40°S in the western South Atlantic, 30°S in the central South Atlantic, and 35°S in the eastern South Atlantic.

Habitat and Biology: This is an epipelagic and oceanic species usually found in waters with surface temperatures ranging from 22° to 31°C. Water colour affects the occurrence of M. nigricans, at least in the northern Gulf of Mexico, where the fish show preference for blue water.

In the western Atlantic, the monthly distribution of Japanese longliner catches shows two main seasonal concentrations; one from January through April in the western South Atlantic, between 5° and 30°S, and the other from June through October, in the western North Atlantic, between 10° and 35°N. May, November and December appear to be transitional months. In the eastern Atlantic, where the blue marlin is less abundant, it occurs mostly off the east coast of Africa between 25°N and 25°S. There are indications of a periodical fluctuation in abundance of this species which is probably due to ecological interaction with other species of marlin. For example, during the fishing season in the northern Gulf of Mexico (April to November), anglers tend to catch more M. nigricans at times when white marlin (Tetrapturus albidus) catches are lowest and vice versa.

In the northwestern Atlantic, 561 individuals of M. nigricans were tagged from 1955 to 1971, but only 4 have been recaptured, all near their respective release points. Although these tag returns are inconclusive, they suggest that this technique might be successful if applied on a larger scale. Unlike Istiophorus albicans, M. nigricans does not form concentrations in coastal waters. In the open ocean, it rarely gathers in schools and is usually found as scattered single individuals.

Little is known about the spawning grounds and seasons. In the western central Atlantic, three larvae have been recorded off Georgia (30°5'N/79°37'W), two off Cat Cay, Bahamas, one at 32°06'N/72°00'W, and one at about 40 miles northeast of Fort Pierce, Florida. Several juveniles were recorded from off Jamaica. In the southwestern Atlantic, 85 larvae were found from off Brazil, between Cabo de Sao Roque and 26°S. Subripe ova are opaque, white to yellow, and 0.3 to 0.5 mm in diameter. Transparent spherical eggs flowing out of a ripe ovary measured 1 mm in diameter.

The Atlantic blue marlin feeds mostly in near-surface waters but sometimes makes trips to relatively deep water for feeding, as is shown by the presence of deep sea fishes such as Pseudoscopelus in the stomachs of specimens caught off Puerto Rico. However, the Atlantic blue marlin is believed not to feed on the surface at night; surface-trolled baits are taken by this species especially in the morning between 10:00 and 11:00 hours. Ovchinnikov (1970) and Rivas (1975) both concluded that the marlin's bill does not play an important role in the capture of food, based on observations that marlins without bills or with broken or malformed bills are as healthy as normal fish. The present author disagrees with these conclusions.

Stomachs of M. nigricans contained dolphinfishes (Coryphaena) and tuna-like fishes, especially frigate mackerel (Auxis) around the Bahamas; tuna-like fishes, predominant in both number and volume, off Puerto Rico and Jamaica, and mainly dolphinfishes and scombrids in the northern Gulf of Mexico.

The size range of the prey taken by this species is relatively wide, including fishes from about 20 to 102 cm total length and octopods from at least 15 cm to about 61 cm (Bimini, Bahamas). Off Puerto Rico, a 135 kg Atlantic blue marlin was found to have swallowed a 38 mm long postlarval surgeonfish while another fish of similar size had ingested a 11 kg squid. In the Gulf of Guinea, a 290 kg M. nigricans had swallowed a bigeye tuna, (Thunnus obesus) weighing about 50 kg.

Size: M. nigricans is smaller than M. mazara, averaging between 136 kg (300 lb) and 181 kg (400 lb). The maximum size of this species exceeds 375 cm body length and 580 kg in weight. However, many anglers report having seen this species reaching sizes up to 680 kg (1 500 lb). The largest specimen recorded by the International Game Fish Association (the all tackle angling record) was from St. Thomas, Virgin Islands and weighed 581.51 kg (1 282 lb). The second-largest was a fish of 461.98 kg (1 018 lb 8 oz) from South Pass, Louisiana, USA. Generally, M. nigricans heavier than 136 kg (300 lb) are females. Throughout the Atlantic, the size of fish caught by commercial longliners ranges from about 230 cm to 345 cm total length (200 to 275 cm body length).

Interest to Fisheries: From 1978 to 1982, catches of M. nigricans have been recorded by several countries from five FAO Fishing Areas (21, 31, 34, 41 and 47). The total world catch was 1 842 t in 1978, 2 160 t in 1979, 2 328 t in 1980, 2 218 t in 1981 and 2 448 t in 1982. Of the above-mentioned five Fishing Areas, the only one that

yielded catches over 1 000 t during this period was the eastern central Atlantic (Fishing Area 34) in 1980 (1 054 t taken predominantly by Cuba). In 1981, 1% (22 t) of the total catch was taken in Fishing Area 21 (northwest Atlantic) by Japan exclusively, 38.1% (846 t) in Fishing Area 31 (western central Atlantic) by Cuba, Venezuela, Japan and others, 24% (532 t) in Fishing Area 34 (eastern central Atlantic) predominantly by Cuba, 14.3% (318 t) in Fishing Area 41 (southwest Atlantic) by several countries, and 22.5% (500 t) in Fishing Area 47 (southeastern Atlantic) by Japan and other several countries (FAO, 1983). In 1982, 0.12% (3 t) of the total catch was taken in Fishing Area 21 exclusively by Japan, 34.3% (839 t) in Fishing Area 31 by Cuba, Japan, Venezuela, Republic of Korea and others, 29.7% (726 t) in Fishing Area 34 by Cuba, Japan, Republic of Korea and others, 9.5% (232 t) in Fishing Area 41 by Japan and other countries, and 26.5% (648 t) in Fishing Area 47 by Japan and China (Taiwan Province)(FAO, 1984).

In the commercial fisheries, the fishing gear currently in use is the conventional or modified Japanese longline. Around Cuba, M. nigricans is caught commercially with "palangres" a type of gear similar to the ordinary longline, but with only a few hooks used. As regards vessels, Japanese-type longliners are used extensively in the commercial fisheries, with certain modifications in size and equipment according to purposes and localities. Small boats powered by sail and/or motors (inboard and outboard) are used for operating the Cuban palangres.

In the sportsfisheries, M. nigricans is taken by ordinary rod and reel methods. Natural (mostly) or artificial baits are trolled along the surface at speeds varying from 4 to 8 knots and usually 2 to 5 lines are used simultaneously.

The quality of the flesh is excellent. It is marketed fresh or frozen.

Local Names: BRAZIL: Agulhao preto; CANADA: Blue marlin, Makaire bleu; CUBA: Abanico, Aguja, Aguja casta, Castero, Prieta, Voladora; FRANCE: Makaire bleu; JAPAN: Nishikuro, Nishikurokajiki; MEXICO: Marlín azul, Marlín negro; MOROCCO: Espadon; PORTUGAL: Espadium azul, Espadium azul do Atlantico, Peito, Peixe agulha; REPUBLIC OF KOREA: Nog-Sae-chi; SOUTH AFRICA: Blue marlin, Blou marlyn; SPAIN: Aguja azul; USA: Blue marlin, Cuban black marlin; USSR: Chernyi marlin, Goluboi marlin; VENEZUELA: Marlín azul; WEST INDIES: Blue marlin, Squadron.

Literature: Krumholz & deSylva (1958); Erdman (1962, 1968); deSylva (1963); Ovchinnikov (1970); Ueyanagi et al. (1970); Mather, Jones and Beardsley (1972); Rivas (1975).

Remarks: The present author believes that the Indo-Pacific blue marlin, Makaira mazara, and the Atlantic blue marlin, Makaira nigricans, are distinct species chiefly because of differences in the pattern of the lateral line system (simple-looped in M. mazara and reticulated in M. nigricans). Many scientistis, however, do not recognize this character as specifically diagnostic and consider M. nigricans as a single pantropical species occurring in the Atlantic, Pacific, and Indian oceans (Rivas, 1956, 1975; Royce, 1957; Briggs, 1960; Robins & de Sylva, 1960; Jones & Silas, 1964; Morrow, 1964).

Tetrapturus Rafinesque, 1810

ISTIO Tetra

Genus: Tetrapturus Rafinesque, 1810, Caratteri di alcuni nuovi generi e nuove specie di animali e piante della Sicilia, con varie osservazioni sopra i medesimi. Palermo, 1810, 105 pp., 20 pl.(ref.p. 54-5, pl.1, fig.1).

Type Species: Tetrapturus belone Rafinesque, 1810.

Synonymy: Skeponopodus Nardo, 1833; Tetraptururus Bonnaterre, 1841 (amended spelling); Tetrapterus Agassiz, 1841 (amended spelling); Tetraplurus Verany, 1847 (? misprint); Scheponopodus Canestrini, 1872 (amended spelling); Marlina Grey, 1928; Kajikia Hirasaka and Nakamura, 1947; Pseudohistiophorus deBuen, 1950, Lamontella Smith, 1956.

Remarks: This genus includes six species of which one (Tetrapturus georgei) still requires proof with regard to its validity. The possibility of existence of a seventh species, the so-called hatchet marlin (Tetrapturus sp.) is even more doubtful.

Tetrapturus albidus Poey, 1860

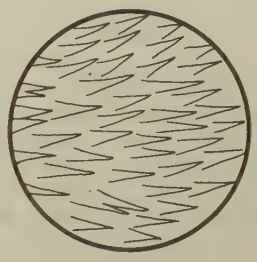
ISTIO Tetra 1

Tetrapturus albidus Poey, Memorias sobre la historia natural de la isla de Cuba, 2:237-244, 258-60, pl. 151 (fig. 1), pl. 16 (figs 2-13), pl. 17 (figs 1,5,6-10,11,26) (Cuba).

Synonymy: Tetrapturus lessonae Canestrini, 1861; Makaira lessonae-Jordan & Evermann, 1926; Makaira albida-Jordan & Evermann, 1926; Lamontella albida-Smith, 1956.

FAO Names: En - Atlantic white marlin; Fr - Makaire blanc de l'Atlantique; Sp - Aguja blanca del Atlántico.

Field Marks: Anterior lobe of first dorsal fin rounded and higher than remainder of fin, the height decreasing gradually backward; anus situated near origin of first anal fin, the distance between them smaller than half of first anal fin height.



scales

Diagnostic Features: Body elongate and fairly compressed. Bill stout and long, round in cross section; nape fairly elevated; right and left branchiostegal membranes completely united to each other, but free from isthmus; no gillrakers; both jaws and palatines (roof of mouth) with small, file-like teeth. Two dorsal fins, the first with 38 to 46 rays, usually with a rounded anterior lobe, higher than body depth anteriorly, then abruptly decreasing in height to about the 12th dorsal fin ray and gently decreasing further backward; first dorsal fin base long, extending from above posterior margin of preopercle to near second dorsal fin origin; second dorsal fin with 5 or 6 rays, its position slightly backward with respect to the second anal fin; two anal fins, the first with 12 to 17 rays, the second with 5 or 6 rays and very similar in size and shape to the second dorsal; pectoral fins long and wide, round-tipped, adpressible against sides of body and with 18 to 21 rays; pelvic fins slender and almost equal to, or slightly shorter than the pectorals. Caudal peduncle well compressed (laterally) and slightly depressed (dorsoventrally), with strong double keels on each side and a shallow notch on both, the dorsal and ventral surfaces; anus situated just in front of first anal fin origin. Lateral line single and obvious, curving above base of pectoral fin and then continuing in a straight line toward the caudal fin base. Body densely covered with elongate bony scales, each with 1 or 2 posterior points. Vertebrae 24 (12 precaudal and 12 caudal). Colour: body blue-black dorsally, silvery white splattered with brown laterally, and silvery white ventrally; usually no blotches or marks on body, but sometimes more than 15 rows of obscure whitish stripes. First dorsal fin dark blue with many black dots; second drosal fin dark blue; pectoral fins blackish brown, sometimes tinged with silvery white; pelvic fins blue-black with a black fin membrane; caudal fin blackish brown.

Geographical Distribution: Based on Japanese commercial longliner's catches, the distribution of T. albidus extends over most of the Atlantic, roughly from 45°N in the North Atlantic to 45°S in the western South Atlantic and 35°S in the eastern South Atlantic. T. albidus is also known from the Mediterranean Sea, and from Bretagne, France, though these records seem to correspond to a few straying individuals.

Habitat and Biology: This is a pelagic and oceanic species, usually swimming above the thermocline. Its distribution varies seasonally, reaching the higher latitudes in both the northern and southern hemispheres only during the respective warm seasons. It is usually found in deep (over 100 m) blue water with surface temperatures over 22°C and salinities of 35 to 37°/oo. Average air temperatures of regions where it occurs are usually moderate to warm (15° to 25°C). Currents of 0.5 to 2 knots occur over much of its habitat. Angling success for white marlin in the Gulf of Mexico is greater in proportion to the blueness of the water, and poorer in proportion to its greenness. In some areas, T. albidus is found to concentrate near rips (usually occurring at interfaces between different masses of water) or weed lines. Its differential distribution is also influenced by

bottom topography. Steep dropoffs, submarine canyons and shoals, when located in areas with suitable water conditions, are often the scene of important feeding concentrations of this species and exceptionally productive fishing.

The recovery of tagged individuals shows that this species may accomplish fairly long journeys, but not the extensive transoceanic migrations achieved by the bluefin tuna (Thunnus thynnus) and the albacore (Thunnus alalunga). Tagging experiments carried out by the Cooperative Game Fish Tagging Program of the Woods Hole Oceanogrphic Institution have produced considerable insights into the movements of T. albidus in the western North Atlantic. As of January 1973, some 9 000 of these fish had been marked in that area, and 144 tags had been returned (Mather, Clark and Mason, 1975).

The information presently available indicates that T. albidus spawns once a year. Knowledge of spawning seasons, areas, and mating behaviour is incomplete, because of difficulties in identifying the eggs and larvae and the lack of continuous and comprehensive gonad studies. Ueyanagi et al. (1970) concluded that this species migrates into subtropical waters to spawn, with peak spawning occurring in early summer. The spawning areas are found in deep and blue oceanic waters, generally at high surface temperatures (20 to 29°C, except in the southern Atlantic gyrals) and high surface salinities (over 35°/oo). Except off Cabo Frio, Brazil, the productivity of these waters is considered to be low.

T. albidus is not generally considered a schooling fish, and is most often found as single individuals or in pairs "tailing" with only the dorsal lobe of their caudal fins showing. Small schools (5 to 12 fish), however, are occasionally seen feeding on schools of bait, or tailing, but loose aggregations of numerous fish scattered over fairly large areas are most typical. They may school according to size or sex at various seasons of the year.

Hemingway (1935) described "white marlins" breeding off Cuba in May: "they breed in the same way the groupers do, except that as current-dwelling fishes, they do this in the current instead of on the reef. The female marlin heads into the current while the male heads in the opposite direction, and while they are side by side, the female expells the eggs and the male the milt; the male then catches the eggs in the basket-like opening of his gill covers and lets them pass out through his mouth". The feasibility of the latter action seems questionable, but the observation of paired spawning may be true.

Atlantic white marlin are known to kill or stun their food by spearing it or hitting it with their bill. This may not always be true, however, as whole specimens found in the stomachs appeared to be unscathed. In such cases the marlin may have simply overtaken the prey. Squids seem to play a most important part as food of T. albidus in the different areas of its abundance. In the Gulf of Mexico, the most consistently important food items observed from 1966 to 1971 were squids, dolphinfish (Coryphaena hippurus), and hardtail jack, (Caranx crysos). Mackerels were next in importance and flying fishes and bonitos also played a big part. Other food items found were cutlassfishes, swellfishes, herrings, barracudas, moonfishes, triggerfishes, remoras, hammerhead sharks, and crabs, but to a much lesser and more inconsistent degree. Along the central Atlantic coasts, the favorite food items appear to be round herring (Etrumeus teres) and squid (Loligo pealei), but carangids are also well represented in addition to several other species.

Size: This species reaches a maximum size of over 280 cm in total length and over 82 kg in weight. The all tackle angling record given by the International Game Fish Association is a fish caught off Victoria, Brazil, on 8 December 1979, weighing 82.50 kg (181 lb 14 oz). Other large records (over 70 kg) are: 79 kg (174 lb 3 oz) off Victoria, Brazil, on 1 November 1975; 77.40 kg (170 lb 10 oz) off Gurapari, Espirito Santo, Brazil on 2 December 1978; and 73.2 kg/274.3 cm total length at Pompano Beach, Florida on 25 April 1953. The size of Atlantic white marlins caught by commercial longliners ranges from 130 to 210 cm body length (mostly around 165 cm body length).

Interest to Fisheries: In the period from 1978 to 1981, catches of T. albidus have been reported from five FAO Fishing Areas (21, 31, 34, 41 and 47) by Japan and the Republic of Korea. The world total catch was very small throughout these areas: 204 t in 1981, 93 t in 1979, 119 t in 1980, 121 t in 1981 and 131 t in 1982 (FAO, 1984).

The types of fishing gear used for billfishes and tunas, including T. albidus, vary somewhat from one area to another but all employ the basic hook and line technique. The major gear classifications are rod and reel, handline and longline. The fishing gear is operated from various types of boats, ranging from large ocean-going longliners and very luxurious sportsfishing crafts down to outboard wooden or FRP motorboats and small 4.5 to 6 m wooden sailboats and row boats in the Caribbean area.

The quality of the flesh is excellent. It is mostly marketed frozen in Japan, and fresh locally.

Local Names: BRAZIL: Agulhao, Agulhao branca, Bicuda, Espadarte meca; CANADA: Makaire blanc, White marlin; CUBA: Aguja blanca, Aguja de paladar, Blanca, Cabezona; FRANCE: Makaire blanc; ITALY: Marlin bianco; JAPAN: Nishimaka, Nishimakajiki (name for white marlin landed in Japan); MORROCO: Espadon; PORTUGAL: Agulha, Espadium branco, Espadium pequenho, Espadon branco do Atlantico; REPUBLIC OF KOREA: Bag-sae-chi; SOUTH AFRICA: White marlin, Wit marlyn; SPAIN: Aguja blanca, Alfiler, Alton, Cometa, Pez aguja; USA: Skilligalee, White marlin; USSR: Belyi marlin; VENEZUELA: Aguja blanca; WEST INDIES: White marlin.

Literature : Wallace & Wallace (1942); Gibbs (1957); de Sylva (1963); Stephens (1965); Ueyanagi et al. (1970); Nakamura (1971); Nakamura & Rivas (1972); Robins (1974); Mather, Clark & Mason (1975).

Tetrapturus angustirostris Tanaka, 1915

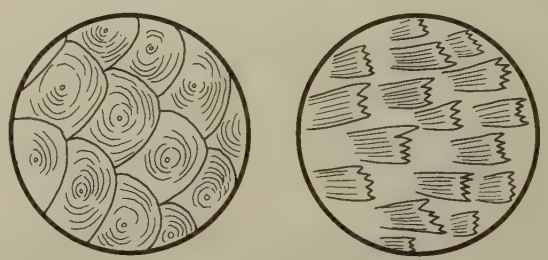
ISTIO Tetra 3

Tetrapturus angustirostris Tanaka, 1914 to 1915, figures and description of the fishes of Japan, 18:pl.88 (fig.285) (1914), 19:324 (1915) (Sagami Bay, Japan).

Synonymy : Tetrapturus illingworthi Jordan & Evermann, 1926; Tetrapturus kraussi Jordan & Evermann, 1926; Pseudohistiophorus angustirostris-de Buen, 1950; Pseudohistiophorus illingworthi-de Buen, 1950.

FAO Names : En - Shortbill spearfish; Fr - Makaire à rostre court; Sp - Marlín trompa corta

Field Marks : Bill very short, usually less than 15% of body length; pectoral fins narrow and short, less than 15% of body length; distance between anus and anal fin origin nearly equal to anal fin height.



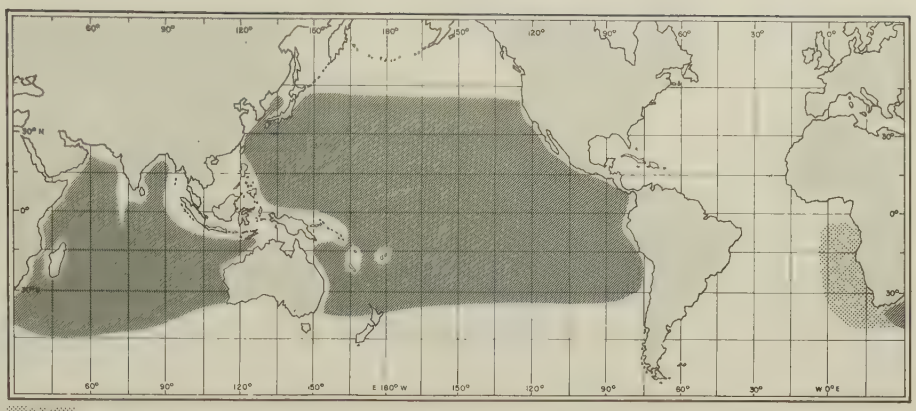
ca. 55 cm. body length

ca. 160 cm. body length

Schematic drawings of scales (not same size)

Diagnostic Features : Body elongate and fairly compressed. Bill short and slender, round in cross section; lower jaw shorter than upper jaw, but still projecting; nape nearly straight; right and left branchiostegal membranes completely united to each other, but free from isthmus; no gillrakers; both jaws and palatines (roof of mouth) with small, file-shaped teeth. Two dorsal fins, the first with 45 to 50 rays and with a pointed anterior lobe, higher than body depth anteriorly, the fin then abruptly decreasing in height to about the 19th dorsal fin ray and gradually increasing thereafter, but maintaining a uniform height posteriorly; first dorsal fin base long, extending from above posterior margin of preopercle to near second dorsal fin origin; second dorsal fin with 6 or 7 rays, its position slightly backward with respect to the second anal fin; two anal fins, the first with 12 to 15 rays, and the second with 6 to 8 rays and very similar in size and shape to the second dorsal; pectoral fins with 17 to 19 rays; pelvic fins slender, about twice the length of the pectorals. Caudal peduncle fairly compressed (laterally) and slightly depressed (dorsoventrally) with double keels on each side and a shallow notch on both dorsal and ventral surfaces; anus situated far anterior to first anal fin origin, at a distance usually longer than the height of first anal fin. Lateral line single and well visible. Body densely covered with elongate bony scales, each scale with 3 to 5 posterior points. Vertebrae 24 (12 precaudal and 12 caudal). Gonad Y-shaped. Colour: body dark blue dorsally, blue splattered with brown laterally, and silvery white ventrally, without dots or stripes. First dorsal fin dark blue, without dots or blotches; remaining fins brown or dark brown; bases of first and second anal fins often tinged with silvery white.

Geographical Distribution: T. angustirostris is distributed throughout the tropical and temperate waters of the Pacific and Indian oceans and is thought to be strongly oceanic, rarely entering coastal waters. Its latitudinal range based on longline catches, extends roughly from 40°N to 35°S in the Pacific Ocean and from 20°N to 35°-45°S in the Indian Ocean.



Area of occasional distribution, or invasion, (no spawning)

Habitat and Biology: T. angustirostris is an oceanic, pelagic fish which does not generally occur in coastal or enclosed waters but is found well offshore. Longline fisheries in the equatorial Indian Ocean take relatively few individuals in the upper water layers (0 to 200 m) over depths shallower than 914 m (500 fathoms) while the highest catch rates are obtained above the 915 to 1830 m (501 to 1000 fathoms) isobaths. The catch rate decreases over deeper areas. The population density, based on catch per unit of effort data of the longline fishery appears to be usually low, except in the northwestern Pacific between 15° and 30°N where it is high from about November through February. This species is apparently more abundant during the southeast monsoon period in the western Indian Ocean, when the maturity of female fish is more advanced and the surface temperatures are at the lowest (mean 25.5°C). Although some stray individuals of this fish are found in the Atlantic Ocean, this species is believed to have its spawning grounds and principal populations only in the Pacific and Indian oceans.

Spawning is believed to occur mainly during the winter months, especially in warm offshore currents with surface temperatures of about 25°C. Thus fish caught in waters around Taiwan Island were found to release ripe eggs in November. Females with ripe ovaries were also reported to occur during the winter months in the western Indian Ocean, and in March in the central Pacific Ocean. From the occurrence of larvae and mature fish, spawning seems to be also more active in winter than in summer in the tropical and subtropical waters of the Pacific and Indian oceans between 25°N and 25°S. The frequency distribution of the diameters of eggs shed by the shortbill spearfish ranges roughly from 1.3 to 1.6 mm, with a mean of 1.442 mm in the equatorial western Indian Ocean. The eggs released from the ovaries around Taiwan Island and preserved in alcohol are spherical and about 1 mm in diameter. The ovarian eggs of nearly mature (not fully ripe) females are almost colourless and semitransparent, with slightly yellowish brown oil globules which later unite into two fairly large globules. At this stage, the diameter of the ovarian eggs is about 0.8 mm.

Like in other billfishes, stomach contents of T. angustirostris differ from place to place and from season to season. Data from Japanese longline research cruises show that (i) in the eastern Pacific Ocean this species feeds mainly on cephalopods and fishes, such as Gempylidae, Scombridae, Exocoetidae, Bramidae, Stromateidae, Alepisaurus spp., Auxis spp., Katsuwonus pelamis etc.; (ii) in the central South Pacific Ocean, the number of fish species preyed upon is more limited than in Tetrapturus audax and Makaira mazara, but the crustacean and cephalopod species found in stomachs are nearly the same as those taken by other billfishes. On the other hand, deepwater fishes such as Myctophidae, Triacanthidae and Polyipnus are lacking, which suggests that T. angustirostris swims in shallower waters than T. audax and M. mazara. A comparative analysis of the relative volume of stomach contents of tunas and billfishes from the central South Pacific shows that T. angustirostris and the yellowfin tuna (Thunnus albacares) have their stomachs filled with food more often than the albacore, (Thunnus alalunga), the striped marlin (Tetrapturus audax) or the blue marlin (Makaira mazara) and that T. angustirostris and T. alalunga tend to eat smaller food items than other billfishes and tunas.

Size: The maximum known size of this species is about 2 m in total length and 52 kg in weight. The average length of fish caught by the longline fishery is about 135 cm eye-fork length in the central South Pacific and approximately 150 cm in the eastern Pacific, and the average weight is about 18 kg.

Interest to Fisheries: There are no special fisheries for T. angustirostris, but this species is caught incidentally by tuna longlines and very rarely by trolling or sportsfishing. The catch statistics by Japanese longliners for the Indo-Pacific sailfish (Istiophorus platypterus) includes a negligible proportion of T. angustirostris. Usually, nearshore records roughly apply to I. platypterus and offshore records to T. angustirostris. All in all, the annual total catch of this species is estimated at several hundred metric tons.

The shortbill spearfish is marketed mostly frozen in Japan. The flesh is scanty and not of high value, compared with that of other billfishes. It is mainly used for fish cakes and sausages.

Local Names: JAPAN: Fuurai, Fuuraikajiki, Sanmakajiki, Sugiyama; SOUTH AMERICA: Pez aguja corta; USA: Japanese spearfish, Shortbill spearfish, Shortnose spearfish, Shortnosed spearfish, Slender spearfish; USSR: Kop'jenosjets; VIET NAM: Cá cờ'Nhâtban.

Literature : Nakamura (1937, 1938); Royce (1957); Ueyanagi (1962); Watanabe & Ueyanagi (1963); Howard & Ueyanagi (1965); Koga (1967); Merrett (1970, 1971); Howard & Starck (1975); Kikawa (1975).

Tetrapturus audax (Philippi, 1887)

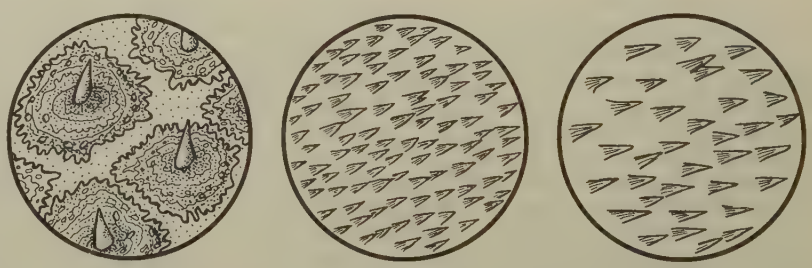
ISTIO Tetra 5

Histiophorus audax Philippi, 1887, Anal.Univ.Chile, 71:35-8, pl.8 (figs 2 to 3) (Iquique, Chile).

Synonymy : Istiophorus audax-Abbott, 1899; Tetrapturus mitsukurii Jordan & Snyder, 1901; Tetrapturus ectenes Jordan & Evermann, 1926; Makaira grammatica Jordan & Evermann, 1926; Makaira holei Jordan & Evermann, 1926; Makaira zelandica Jordan & Evermann, 1926; Makaira audax-Jordan & Evermann, 1926; Marlina mitsukurii-Grey, 1928; Marlina zelandica-Whitley, 1937; Kajikia mitsukurii-Hirasaka & Nakamura, 1947; Kajikia formosana Hiraska & Nakamura, 1947; Tetrapturus tenuirostratus Deraniyagala, 1951; Tetrapturus acutirostratus Deraniyagara, 1952; Makaira formosana-Matsubara, 1955; Marlina audax-Smith, 1956; Tetrapturus audax-Robins & de Sylva, 1961; Makaira audax zelandica-Whitley, 1962.

FAO Names : En - Striped marlin; Fr - Marlin rayé; Sp - Marlín rayado.

Field Marks : Anterior lobe of first dorsal fin pointed and higher than remainder of the fin, the height decreasing gradually backward; anus situated near origin of first anal fin, the distance between them smaller than half of anal fin height; tips of pectoral and first anal fins pointed.



ca. 12 cm. body length

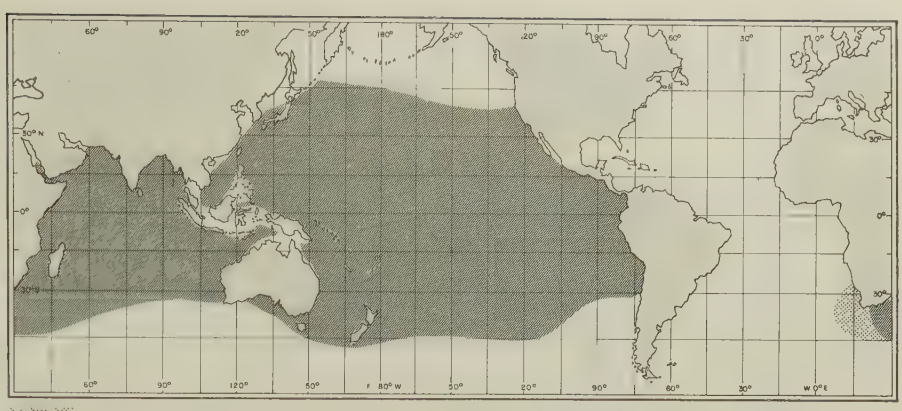
ca. 100 cm. body length

ca. 180 cm. body length

Schematic drawings of scales (not same size)

Diagnostic Features : Body elongate and fairly compressed. Bill stout and long, round in cross section; nape fairly elevated; right and left branchiostegal membranes completely united to each other, but free from isthmus; no gillrakers; both jaws and palatines (roof of mouth) with small, file-like teeth. Two dorsal fins, the first with 37 to 42 rays, usually with a pointed anterior lobe, higher than (or occasionally equal to) body depth anteriorly, the fin then abruptly decreasing in height to about the 10th dorsal fin ray and gently decreasing further backward; first dorsal fin base long, extending from above posterior margin of preopercle to just in front of second dorsal fin origin; second dorsal fin with 5 or 6 rays, its position slightly backward in respect to the second anal fin; two anal fins, the first with 13 to 18 rays, the second with 5 or 6 rays and very similar in size and shape to the second dorsal; pectoral fins long and narrow, with pointed tips, adpressible against sides of body and with 18 to 22 rays; pelvic fins slender and almost equal to, or slightly shorter than the pectorals in large specimens, and slightly longer than pectorals in smaller individuals. Caudal peduncle well compressed (laterally) and slightly depressed (dorsoventrally), with a pair of keels on each side and a shallow notch on both, the dorsal and ventral surfaces; anus situated just in front of first anal fin origin. Lateral line single and obvious, curving above base of pectoral fin and then continuing in a straight line toward the caudal fin base. Body densely covered with elongate bony scales, each with 1 or 2 posterior points. Vertebrae 24 (12 precaudal and 12 caudal). Colour: body blue-black dorsally and silvery white ventrally, with about 15 rows of cobalt-coloured stripes, each consisting of round dots and/or narrow bands. First dorsal fin dark blue; other fins usually dark brown, sometimes tinged with dark blue; bases of first and second anal fins tinged with silvery white.

Geographical Distribution : T. audax occurs mainly in the tropical, subtropical and temperate waters of the Pacific and Indian oceans. Japanese longline catch data collected over many years show that the distribution pattern of this species within the Pacific Ocean is horseshoe-shaped, with the base of the horseshoe located along the Central American coast. T. audax is occasionally found on the Atlantic side of the Cape of Good Hope (Talbot & Penrith, 1962) and one individual was caught off Angola, West Africa in October 1976, having probably strayed from the Indian Ocean as in a few cases of Tetrapturus angustirostris and Makaira indica. The latitudinal range limits of T. audax, based on data from the commercial longline fishery, extend from about 45°N in the North Pacific to 30°S in the eastern South Pacific and to 45°S in the western South Pacific, as far south as 45°S in the southwestern Indian Ocean and 35°S in the southeastern Indian Ocean.



Area of occasional distribution, or invasion, (no spawning)

Habitat and Biology : This is an epipelagic and oceanic species, usually swimming above the thermocline. Parin (1968) included it among the holoepipelagic species which inhabit the isothermic, surface-pelagic layer of the ocean at all stages of their life cycle, and are usually confined to tropical and subtropical waters where permanent thermoclines exist, but penetrate higher latitudes in the local warm seasons. However, the striped marlin has a somewhat atypical distribution as compared to most other billfishes and tunas, and seems to prefer more temperate waters. In the Pacific, its distribution resembles that of the albacore (Thunnus alalunga) and the bluefin tuna (Thunnus thynnus), in contrast to that of the other billfishes and tunas. In the Indian Ocean, however, it is found in warmer waters. The total distributional range of this species, is generally bounded by the 20° and 25°C isotherms, at least in the western Pacific Ocean. This is the most dominant and widely distributed of all billfishes, especially in the eastern and northcentral Pacific, where it is much more abundant than in the western Pacific. In the Indian Ocean, the striped marlin is abundant in the western Arabian Sea.

Larvae of striped marlin have been recorded from the western North Pacific (west of 180° long.) between 10° to 30°N, and from the central South Pacific (west of 130°W) between 10° and 30°S. They are most abundant in the respective local early summers, with peak occurrences during May through June in the western North Pacific, and in November and December in the central South Pacific. The seasonal occurrence of mature females coincides with that of the larvae. While the distribution of larvae for the eastern Pacific (east of 120°W) is not known, mature fish are reported to occur there between 5° and 20°N, largely in May and June. Larvae have also been reported to occur in the Banda and Timor seas in January and February, in the eastern Indian Ocean in October and November between 6°N and 6°S, and in the western Indian Ocean between 10°S and 18°S in December and January. Mature females are found in March and May in the Bay of Bengal, although larval occurrence is not yet known there. The lower temperature limit in the distribution of larvae is approximately 24°C, both in the Indian and Pacific oceans. However, larval distributions in the two oceans differ in that, in the Pacific, the larvae of this species are scarcely found in equatorial waters. It has been noted that larvae of T. audax are not likely to appear in the Kuroshio Current area, while those of the Indo-Pacific sailfish, Istiophorus platypterus occur there extensively. Two juveniles of striped marlin (12.2 and 14.5 cm body length) were found in stomachs of a yellowfin tuna (Thunnus albacares), and of a dolphinfish (Coryphaena hippurus) taken by longlines on 13 January 1955 at 23°52'S/175°49'W and on 21 December 1964 at 17°5'S/67°29'E. These two occurrences coincide with larval distributions of the species in the South Pacific and Indian oceans, respectively.

The ovarian eggs of striped marlin from New Zealand average about 0.85 mm in diameter shortly before spawning. The size of ovulated eggs is presumed to exceed 1 mm in diameter, considering that the mean diameter of the eggs of the shortbill spearfish (Tetrapturus angustirostris) is 1.442 mm and that the eggs of the Indo-Pacific sailfish (Istiophorus platypterus), measure 1.304 mm in diameter.

T. audax, like the other marlins, does not form dense schools like the tunas, and the individuals are usually dispersed at considerably wide distances. Several fish, however, are often seen together, sometimes following one another, especially during the spawning season. Surfacing is apparently more common with strong wind and high waves. When wind and current are moving in the same direction, the water surface is rather smooth, but when the wind runs against the current, high waves develop and this is when striped marlin are most often seen at the surface around Taiwan Island, usually swimming in the direction of the wind. When surfaced, striped marlins usually swim very slowly, with the upper caudal fin lobe above the surface and the dorsal fin retracted and not showing, a characteristic which reportedly distinguishes them from swordfishes which are unable to depress the dorsal fin and show both the dorsal and caudal fins when surfaced. Striped marlins swim faster and are less easily approached when surfaced than the swordfish. Like other billfishes and tunas, they tend to school by size. For example, in the eastern Pacific, fish on the southern spawning grounds (forming a single size mode at 180 to 200 cm eye-fork length = 83.9 to 86.1% of body length) are larger than those on the northern spawning grounds

(two size modes, one at 140 cm and one at 180 cm). Smaller striped marlins occur in equatorial waters of the Pacific, but these small fish are absent between 5° and 16°S; in midlatitudes (15° to 30°S) of the central South Pacific, a longitudinal stratification is apparent, the larger fish (over 180 cm eye-fork length) occurring in the western Pacific; harpooned fish tend to be larger than longlined fish in the East China Sea, and the harpooned fish are also fatter at a given length.

Dolphinfishes (Coryphaena spp.), wahoo (Acanthocybium solandri) and the pelagic large sharks (Prionace, Isurus, Lamna, Carcharhinus and Alopias) feed on many of the same forage organisms as the striped marlin. Its closest competitors for food are possibly the other billfishes and larger tunas. The striped marlin, however, tends to feed more on epipelagic organisms and less on mesopelagic ones than the swordfish and the oceanic tunas. Food habits do not appear to vary significantly with sex or size, at least in adults. Considerable variation in species composition of the diet occurs, however, with seasons and geographic localities. T. audax, like other billfishes and tunas, is thought to be carnivorous and a non-selective feeder. Some of its reported major forage species by localities are: Fistularia sp., Auxis, sp., squid (East Africa); Scomberoesox saurus, Arripis trutta, Loligo sp., Ommastrephes sloani, Caranx lutescens, Scomber japonicus (New Zealand); Alepisauridae, Clupeidae (Tasman Sea); Gempylus serpens, Cololabis saida, Engraulis mordax, Sardinops caerulea, Trachurus symmetricus (California); Etrumeus teres, Fisturalia sp., Argonauta sp., squid (Mazatlan, Mexico); Etrumeus teres, Scomber japonicus, Fistularia sp., squid (Baja California, Mexico); Auxis spp., Bramidae, Gempylidae, squid (eastern North Pacific); Alepisaurus spp., squid (eastern South Pacific); squid (Peru-Chile); Engraulis ringens, Trachurus symmetricus, squid (Chile).

Predators of adults of this species are probably extremely rare or almost inexistent, the only likely candidates being some of the large pelagic sharks and the toothed whales, although there are many predators to the earlier life-stages of the striped marlin.

Size : The maximum size attained by this species exceeds 350 cm in total length and 200 kg in weight. The all tackle angling record is a fish caught off the Cavalli Islands, New Zealand, on 14 January 1977, weighing 189.37 kg (417 lb 8 oz). Other records of large specimens (over 180 kg) are the following: 183.47 kg (404 lb 8 oz), Bay of Islands, New Zealand, on 12 March 1980; 181.89 kg (401 lb), Cavalli Islands, New Zealand, 24 February 1970; 180.53 kg (398 lb), Mayor Island, New Zealand, 30 December 1974 (IGFA, 1981). All world records for both men and women recognized by IGFA are from New Zealand, except a record from Botany Bay, Sydney, on 24 October 1976 (161.93 kg=357 lb for men's 30 lb line class).

Size at first capture (longline fisheries) of T. audax is approximately 80 cm eye-fork length (= 83.9 to 86.1% of body length). Around Taiwan Island, size at first maturity is generally estimated between 140 cm and 160 cm eye-fork length, and the biological minimum size of males at about 137 cm eye-fork length. The maximum size in commercial fisheries is probably about 290 cm eye-fork length or 258.6 kg (570 lb). The sizes of fish taken by commercial longliners range mainly from 205 to 225 cm body length in the northern part of the western North Pacific, between 145 and 185 cm body length in the southern part of the western North Pacific, between 235 and 255 cm body length in the central North Pacific, and about 280 cm body length in the western South Pacific.

Interest to Fisheries : In the period from 1978 to 1982, catches of T. audax have been reported from seven FAO Fishing Areas (51, 57, 61, 71, 77, 81 and 87), mostly by Japan and the Republic of Korea. The total world catch was 15 426 t in 1978, 15 988 t in 1979, 18 429 t in 1980, 15 664 t in 1981 and 15 460 t in 1982. Only 13.6% (2 132 t) of the 1981 total catch was taken in the Indian Ocean, and 86.4% (13 532 t) in the Pacific Ocean, particularly in Fishing Area 61 (northwest Pacific) with 7 229 t predominantly by Japan, in Fishing Area 77 (eastern central Pacific), with 2 414 t predominantly by Japan, and in Fishing Area 87 (southeast Pacific) with 2 217 t by Japan and the Republic of Korea (FAO, 1983); of the 1982 catch, 12.6% (1 949 t) was taken in the Indian Ocean and 87.6% (13 511 t) in the Pacific Ocean, predominantly by Japan, China (Taiwan Province) and the Republic of Korea (FAO, 1984).

The commercial catch of T. audax is taken mostly by surface longlining, while harpooning may be responsible for less than 1% of the total catch in recent years. The longliners aim chiefly at tunas and marlins which are frequently swimming at depths between 100 and 150 m. Longline gear consists of a mainline, float lines, branch lines, hooks, bouys including several radio-bouys, and flags. Several hundred of these units (each unit is referred to as a "basket") are joined in a series to make up a set of longline. The longline is retrieved with a line hauler. Japanese longliners in the eastern Pacific use about 2 000 hooks (about 400 baskets) per set. Due to recent manpower problems, considerable effort has been directed toward developing labour-saving devices in longlining. The reel-type and the tub-type of longlining are two examples of this development. In the reel-type the mainline (usually wire) is continuous and reeled onto a large drum, while in the tub-type, the retrieved line is coiled into a large tub. In harpooning, the electric harpoon has been recently introduced in Japanese fisheries to speed up the killing of the fish.

The quality of the flesh is the best among billfishes for sashimi and sushi. It is marketed mostly frozen, sometimes fresh.

Local Names : AUSTRALIA: Striped marlin; CHILE: Pez aguja; CHINA: Chi zuo fo yii, Hung ju chi yii, Hung ju ting pan; JAPAN: Achinoiyo, Achinoiyu, Achinuigu, Akinoio, Akinoiyo, Amenashi, Bai, Boke, Chiruguwa, Dainanbo, Haihage, Hainouo, Haise, Mage, Maka, Makajiki, Masashi, Masasu, Naeragi, Naidonbo, Nairage, Nairagi, Nairanbo, Neeranbo, Nooragi, Nouragi, Oiragi, Oiraki, Okajiki, Sashi, Sasu, Shitore, Shiutome, Tenguzawara,

Tsukinbo, Unjiachi; KENYA: Nduaro; MEXICO: Agujón, Marlín, Marlín rayado, Pez puerco; NEW CALEDONIA: Empéreur, Marlin rayé, Empéreux; NEW ZEALAND: New Zealand marlin, Striped marlin; PHILIPPINES: Dugso, Liplipan, Marasugi, Spearfish; REPUBLIC OF KOREA: Cheong-sae-chi; SRI LANKA: Haura; USA: Barred marlin, Pacific striped marlin, Spearfish, Spikefish, Striped marlin, Striped swordfish; USSR: Polosatii marlin; VIET NAM: Cá cò mitsukurii.

Literature : Nakamura, H. (1938); Ueyanagi (1959, 1964); Jones & Kumaran (1964); Howard & Ueyanagi (1965); Nakamura, I. (1968); Parin (1968); Kume & Joseph (1969, 1969a); Ueyanagi & Wares (1975); and Silas & Pillai (1982).

Remarks : Honma & Kamimura (1958) and Kamimura & Honma (1958) advanced the hypothesis that North and South Pacific populations of this species, being quite separate from each other, may represent different species, based on differences in pectoral fin length, and ecology. Further study is needed on this problem.

Tetrapturus belone Rafinesque, 1810

ISTIO Tetra 6

Tetrapturus belone Rafinesque, 1810, Caratteri di alcuni nuovi generi e nuove specie di animali epiante della Sicilia, con varie osservazioni sopri i messimi. Palermo, 1810, 105 pp., 20pl.(ref.p. 54-5, pl.1, fig. 1).

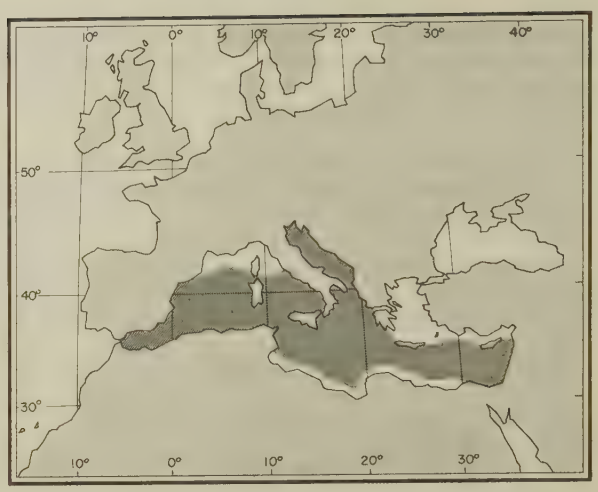
Synonymy : Skeponopodus typus Nardo, 1833; Tetrapterurus belone-Bonaparte, 1841; Tetrapterus belone-Agassiz, 1843; Tetraplurus belone-Verany, 1847; Histiophorus belone-Günther, 1860; Scheponopodus prototypus Canestrini, 1872; Histiophorus (Tetrapturus) belone-Lütken, 1876; Makaira belone-Tortonese, 1958.

FAO Names : En - Mediterranean spearfish; Fr - Marlin de la Méditerranée; Sp - Marlín del Mediterráneo.

Field Marks : Bill very short, about 18% of body length; pectoral fins narrow and short, less than 15% of body length; distance between anus and anal fin origin nearly equal to anal fin height.

scales

Diagnostic Features : Body elongate and fairly compressed. Bill rather short and slender, round in cross section; nape almost straight; right and left branchiostegal membranes completely united to each other, but free from isthmus; no gillrakers; both jaws and palatines (roof of mouth) with small, file-like teeth. Two dorsal fins, the first with 39 to 46 rays and a rounded anterior lobe higher than body depth anteriorly, the fin then abruptly decreasing to about the 10th dorsal fin ray and keeping the same height further backward; first dorsal fin base long, extending from above posterior margin of preopercle to just in front of second dorsal fin origin; second dorsal fin with 5 to 7 rays, its position backward with respect to the second anal fin by half the length of the anal fin base; two anal fins, the first with 11 to 15 rays, the second with 6 or 7 rays and very similar in size and shape to the second dorsal; pectoral fins short (10 to 13% of body length), adpressible against sides of body, their upper margins curved, lower margins nearly straight and tips pointed, with 16 to 20 rays; pelvic fins long and slender, slightly shorter than twice the pectoral fin length and depressible into deep ventral grooves. Caudal peduncle well compressed (laterally) and slightly depressed (dorsoventrally), with strong double keels on each side and a shallow notch on both, the dorsal and ventral surfaces; anus situated far anterior to first anal fin origin. Lateral line single and obvious, its arch ending between midpoint and tip of pectoral fin. Body densely covered with elongate bony scales, each with 3 to 5 posterior points. Vertebrae 24 (12 precaudal and 12 caudal). Colour: body dark bluish grey to nearly black dorsally and silvery white ventrally; usually no blotches or marks on body or fins.



Geographical Distribution : T. belone is limited in its distribution to the Mediterranean Sea, being considerably abundant around Italy. Its eastern distributional limits have not been clearly defined and there have been no records of its occurrence in the Black or the Aegean seas. Although juveniles are known from off Lebanon and Haifa, Israel, no adults have been reported east of the Ionean Sea. T. belone is the most common istiophorid in the central basin of the Mediterranean and its life cycle is completed inside this sea as far as is known to date. Reliable literature records of this species are from around Sicily, the Straits of Messina, Palermo, Taranto, the Gulf of Naples, Venice, the Ligurian Sea, Malta, Mallorca, the Adriatic Sea, and Split, Yugoslavia (adults); Haifa and Lebanon (juveniles); the Straits of Messina (larvae).

Habitat and Biology : Like other billfishes, this species probably swims in the upper 200 m water layer (epipelagic), generally above or within the thermocline. It is frequently reported to travel in pairs, this being known to occur in other istiophorids, possibly corresponding to a feeding behaviour. In the Straits of Messina, the area of most heavy fishing, adults occur in August and September, and occasionally in October and November. They seem to prefer the upper water layers of the Straits, a fact that may well be associated with upwelling and the consequent concentration of food in these waters.

Winter or spring might not be an unreasonable hypothesis for the spawning season of this species. Its pelagic eggs have been found in plankton collections from the Straits of Messina; they average 1.48 mm in diameter and the oil globule is yellow-green; the eggs are incubated for several days and their development has been described (Sparta, 1953, 1961).

T. belone probably feeds on pelagic fishes, such as sardines (Clupeidae), flyingfishes (Exocoetidae), carangids, scombrids, dolphinfishes (Coryphaenidae) and others. Around Sicily, it pursues dolphinfishes, Atlantic sauries, sardine-like fishes, needlefish (Belone belone) and pilotfish (Naucrates ductor).

T. belone is ecologically similar to Xiphias gladius, Tetrapturus albidus, Thunnus thynnus and some large sharks, with which it competes for food. Because of its relatively large size, it is probably not preyed upon extensively in the adult phase, although the larval and juvenile stages are taken by large pelagic fishes.

Size : The maximum size reached by this species exceeds 240 cm in body length and 70 kg in weight. The usual size composition in commercial catches ranges from 10 to 30 kg (mostly 14 to 18 kg) and averages about 200 cm in body length.

Interest to Fisheries : T. belone is usually taken at the surface by harpoons, longlines, driftnets and setnets. In the Gulf of Castellammare, Sicily, and near the towns of Torretta, Granitola and Marinetta, a few individuals are taken by tuna traps. It is also occasionally caught by flag lines and drifting handlines.

The fishery of this species is incidental to those for swordfish (Xiphias gladius), bluefin tuna (Thunnus thynnus) and albacore (Thunnus alalunga). In the Straits of Messina, the gear most often used is the harpoon (fiocine) although this species is also occasionally caught by nets (revastina) normally used for the Atlantic saury, locally called "costardella", on which T. belone feeds. To the south of the Straits of Messina, T. belone is taken at night with vertical nets (palamideras) normally used to catch albacore.

No quantitative data are available on the annual or seasonal catch.

Local Names : ALGERIA: Auggia imbriale; FRANCE: Marlin, Poisson-pique; ITALY: Acura 'mperiale (regional variations of spelling and pronounciation based on Aguglia imperiale), Aguggha imperiali, Agugghia 'mpiriale, Aguglia imperiale, Aguglia pelerana, Ugghia 'mpriali, Ugulia imperiali; JAPAN: Chichukaifuurai, Nishifuuraikajiki (even though this species does not occur around Japan, the Japanese have a keen interest to have names for all billfishes); MALTA: Pastardella; MONACO: Aguglia imperiale; MOROCCO: Bumkhiat; SPAIN: Marlín; USA: Mediterranean shortbill spearfish, Mediterranean spearfish; YUGOSLAVIA: Iglan, Iglokljun.

Literature : Sparta (1953, 1961); Robins & de Sylva (1960, 1963); Cavaliere (1962); Rodriguez-Roda & Howard (1962); de Sylva (1973, 1975).

Remarks : Because of difficulties in identification of juvenile and adult billfish, it is possible that this species is more widely distributed in the Mediterranean Sea than has been reported in the literature, and that Mediterranean spearfish may have been identified by sports- and commercial fishermen as white marlin, Tetrapturus albidus, a species which also occurs in the western and central Mediterranean Sea.

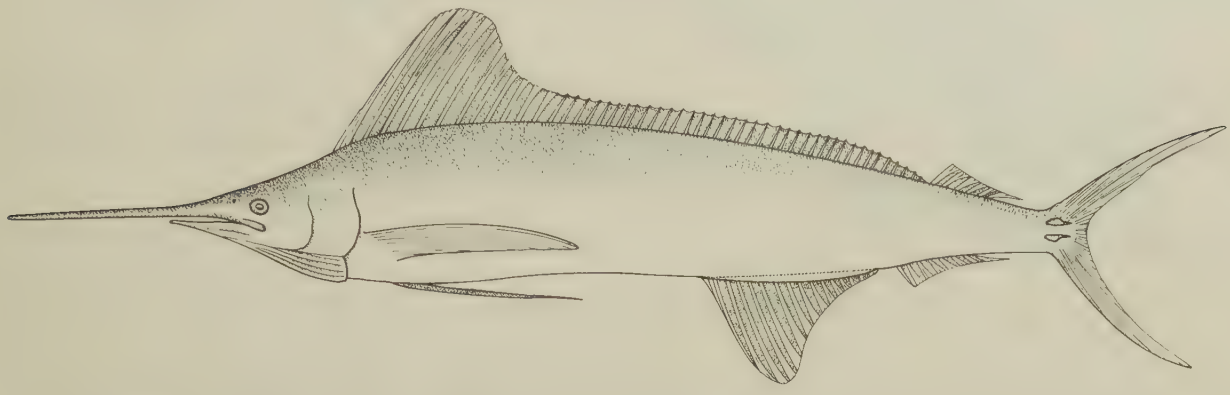
Tetrapturus georgei Lowe, 1840

ISTIO Tetra 4

Tetrapturus georgii Lowe, 1840, Proc.Zool.Soc.London, 8:36-7 (Madeira).

Synonymy : Tetrapturus georgii-de Sylva, 1973; Tetrapturus georgei-Robins, 1874.

FAO Names : En - Roundscale spearfish; Fr - Makaire épée; Sp - Marlín peto



Field Marks : First dorsal fin unspotted; tips of first dorsal and anal fins rounded; distance between anus and anal fin origin nearly equal to half of anal fin height; scales on mid-body soft and round.

scales

Diagnostic Features : Body fairly robust and compressed. Bill long and slender, round in cross section; nape moderately humped; right and left branchiostegal membranes completely united to each other, but free from isthmus; no gillrakers; both jaws and palatines (roof of mouth) with small, file-like teeth. Two dorsal fins, the first with 43 to 48 rays, higher than the maximum body depth anteriorly, and lower posteriorly, with a rounded anterior lobe and a long base extending from above posterior margin of preopercle to just in front of second dorsal fin origin; second dorsal fin with 6 or 7 rays, its position slightly backward with respect to the second anal fin; two anal fins, the first high and broadly rounded, with 14 to 16 rays, the second with 5 to 7 rays and very similar in size to the second dorsal; pectoral fins long, subequal to pelvic fins, reaching beyond the curve of the lateral line, adpressible against sides of body and with 19 or 20 rays; pelvic fins long and slender. Caudal peduncle with a pair of keels on each side; anus moderately far from first anal fin origin, at a distance equal to about half the height of first anal fin. Lateral line single and simple. Scales on sides of body rounded anteriorly, only slightly imbricated and soft; scales on dorsal and ventral parts of body elongate, imbricated and stiff. Vertebrae 24 (12 precaudal and 12 caudal). Colour: most probably there are no bars on body, but this is still uncertain; first dorsal fin completely unspotted. Flesh distinctly redder than in T. belone, more similar to T. albidus.

Geographical Distribution : This species is positively known only from the type locality, Madeira, and from the specimens studied by Robins (1974) from Sicily, the Straits of Gibraltar, and the adjacent Atlantic Ocean off southern Portugal. Obviously it can be expected to range widely in the eastern and perhaps central North Atlantic, and clarification of the central and eastern Atlantic records of spearfish from the Japanese longliner's data is of vital importance. The larvae and juveniles and their areas of occurrence are unknown.

Habitat and Biology : The available data are too few to permit a discussion of the seasonal or annual variations in occurrence of this species. It is probably epipelagic and oceanic.

All three of the known females were in a refractary state with no developed ova. They were collected on 27 May, 9 August and 5 October 1961. The only known male, collected on 2 August, had fairly large testes, but was not in spawning condition. Nothing else is known of the bionomics and life history of this species.

Size : Male: 160 cm body length, 21.5 kg body weight; females: 157 cm body length and 20 kg body weight; more or less 1.5 m body length and 23.5 kg body weight; 154 cm body length and 23.5 kg body weight (Robins, 1974).

Interest to Fisheries : No data are available.

Local Names : "Roundscale spearfish" was proposed by Robins (1974) as the English common name for the species in recognition of its peculiar lateral scales. No other names are available to the author.

Literature : de Sylva (1973); Robins (1974).

Remarks : T. georgei resembles most closely the white marlin, T. albidus, especially in the somewhat humped nape and the broadly rounded anterior lobes of the first dorsal and first anal fins. The possibility that the known specimens of T. georgei represent hybrids between other istiophorids has been discussed and rejected by Robins (1974). Further study is strongly needed to clarify the validity of this species.

Tetrapturus pfluegeri Robins & de Sylva, 1963

ISTIO Tetra 2

Tetrapturus pfluegeri Robins & de Sylva, 1963, Bull.Mar.Sci.Gulf Caribb., 3(1):86-69, figs 1-2 (off San Juan, Puerto Rico).

Synonymy : Tetrapturus belone:Fowler, 1936 (and many other authors who had not distinguished this species from Tetrapturus belone Rafinsque, 1810, until Tetrapturus pfluegeri was described by Robins & de Sylva, 1963); Tetrapterus belone La Monte, 1940; Tetrapturus beloni (sic) Briggs, 1958.

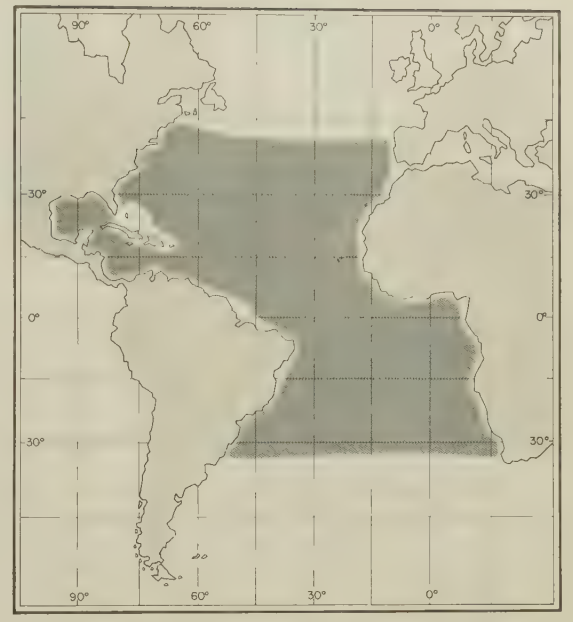
FAO Names : En - Longbill spearfish; Fr - Makaire bécune; Sp - Aguja picuda.

Field Marks : Bill long, its length usually equal to or slightly longer than head length; pectoral fins wide, long and rounded, longer than 18% of body length; anus situated far anterior to first anal fin origin, the distance between anus and anal fin origin nearly equal to anal fin height.

scales

Diagnostic Features : Body elongate and remarkably compressed, its depth very low. Bill slender and rather long, round in cross section; nape nearly straight; right and left branchiostegal membranes completely united to each other, but free from isthmus; no gillrakers; both jaws and palatines (roof of mouth) with small, file-like teeth. Two dorsal fins, the first with 44 to 50 rays, and a rounded anterior lobe higher than body depth anteriorly, the fin then abruptly decreasing in height to about the 9th dorsal fin ray and maintaining almost the same height further backward, except at posterior end; first dorsal fin base long, extending from above posterior margin of preopercle to just in front of second dorsal fin origin; second dorsal fin small, with 6 or 7 rays, its position backward with respect to second anal fin by one third of second anal fin base; two anal fins, the first with 12 to 17 rays, the second with 6 or 7 rays and very similar in size and shape to the second dorsal; pectoral fins long and wide, round-tipped, adpressible against sides of body and with 18 to 21 rays; pelvic fins slender and almost equal to, or slightly longer than the pectorals, and depressible into deep ventral grooves. Caudal peduncle compressed (laterally) and slightly depressed (dorsoventrally), with strong double keels on each side and a shallow notch on both, the dorsal and ventral surfaces; anus situated far anterior of first anal fin origin. Lateral line single and obvious, curving above base of pectoral fin and then continuing in a straight line toward the caudal fin base. Body densely covered with elongate bony scales, each with 2 to 5 posterior points. Vertebrae 24 (12 precaudal and 12 caudal). Gonad y-shaped. Colour: body blue-black dorsally, silvery white, splattered with brown, laterally, and silvery white ventrally. First dorsal fin dark blue without dots or blotches; second dorsal fin dark blue; pectoral fins blackish brown, sometimes tinged with greyish white; pelvic fins blue-black with a black fin membrane; first anal fin dark blue, its base tinged with silvery white; second anal fin blackish brown.

Geographical Distribution : T. pfluegeri was reported only rather recently as a new species by Robins & de Sylva (1963). At that time, this species was known certainly only from the western North Atlantic where it occurs from Georges Bank to Puerto Rico and from the Gulf of Mexico to the Caribbean Sea. Recent surveys of research vessels have clearly shown that this species is also widely distributed in Atlantic offshore waters, much more densely so in the western than in the eastern Atlantic. Its latitudinal range, based on catches by surface longlines of research vessels and commercial boats, extends from approximately 40°N to 35°S.



Habitat and Biology : An epipelagic and oceanic species, chiefly found in offshore waters, usually above the thermocline.

Based on occurrence of larvae and mature fish, spawning of T. pfluegeri takes place throughout wide areas of the tropical and subtropical Atlantic: mature individuals are caught only in the January-March quadrant (mostly) and in the April-June quadrant (less frequently), with the exception of the areas around the Cape Verde Islands and the Caribbean Sea, where some mature individuals have also been recorded in the October-December quadrant; mature individuals have not been recorded from north of 20°N in the western North Atlantic, north of 30°N in the eastern North Atlantic, south of 10°S in the western South Atlantic, or south of 30°S in the eastern South Atlantic. Maturation seems to occur at the same time rather than in the same season both in the northern and southern hemispheres, which could be suggestive of homogeneity of the population of this species. Like the other billfishes, T. pfluegeri feeds chiefly on pelagic fishes and squids. For example, off northeastern Brazil, forage organisms for this species are Alepisaurus spp., Vomer spp., Cephalacanthus spp., anchovies (Engraulidae), dolphinfishes (Coryphaena spp.) and squids. Within any region, billfishes show negligible food selectivity and to some extent are food competitors to each other.

The term "double header" used by sportsfishermen applies to a situation where two longbill spearfish cross the stern and take both trolled baits. Such pair-formation is known for other billfishes and the dolphinfish Coryphaena hippurus. Sexes of the paired fish are unknown and frequently only one of them is boated. The pair-formation, however, is most likely related to hunting procedure and sometimes to mating behaviour. Whether spawning is done in pairs or larger groups is unknown. No information on the reproductive behaviour nor the fecundity is available. Fertilization is external, the eggs have not been identified, but the larvae have been described.

Size : The maximum size of this species exceeds 200 cm in body length and 45 kg in weight. The weight range of T. pfluegeri taken by sportsfishing is from 9 to 36.5 kg, with rare specimens over 45 kg. The most common size caught by surface longlines is about 165 cm body length throughout the Atlantic fishing grounds.

Interest to Fisheries : The longbill spearfish is fished by anglers with the same method they use for other billfishes. No one specifically fishes for this species only. Gear and tackle preferences vary with fishermen but all are well described in the sportsfishing literature, such as Mygdalski (1958), Tinsley (1964), Rybovich (1965), Goadby (1970, 1972), etc. As many as 10 longbill spearfish per year are sent to each of the two principal taxidermy shops in southeastern Florida. Catches everywhere are low; probably fewer than 100 specimens are caught per year by sportsfishermen in the western Atlantic.

Commercial longliners take T. pfluegeri along with tunas, swordfish, other billfishes, wahoo (Acanthocybium solandri), dolphinfishes (Coryphaena spp.), pelagic sharks and miscellaneous other larger pelagic fishes. Catches of this species are incidental and the gear used is the ordinary surface tuna longline. Japanese statistical data lump this species with the Atlantic sailfish, Istiophorus albicans as "spearfish and sailfish"; usually, nearshore records roughly apply to I. albicans and offshore records to T. pfluegeri. In this category, 67 000, 51 000, 118 000, 118 000, 65 000, 59 000, 52 000, 28 000, 39 000, 23 000, 11 000, 8 000, 7 000, 10 000, 7 000, 2 000, 1 000, 2 000 and 3 000 fishes were caught in the years from 1962 to 1980, with an effort ranging from 22 million to 97.5 million hooks per year. The number of fish caught is apparently decreasing recently.

Local Names : JAPAN: Kuchinaga, Kuchinagafuurai (names for this species landed in Japan, see: Howard & Ueyanagi, 1963); USA: Atlantic longbill spearfish, Longbill spearfish; USSR: Malyi kopénosets.

Literature : Robins & de Sylva (1963); Ovchinikov (1970); Ueyanagi et al. (1970); Robins (1975).

Remarks : Outline drawings of five specimens of this species (Nakamura, Matsubara & Iwai, 1968, p. 64, fig. 18) based on field notes, were thought by de Sylva (1973) to correspond to T. georgei rather than to T. pfluegeri, or even to an undescribed species. The present author believes that those five specimens were in fact T. pfluegeri, since very wide individual variations are recognized in external appearance of this species and none of the above-mentioned specimens had the round scales typical of T. georgei; they also showed a wider distance between anus and first anal fin origin (usually greater than height of first anal fin) than in T. georgei (about half the height of first anal fin).

2.4 FAMILY XIPHIIDAE

XIPH

Synonymy : None.

Remarks : This family includes a single species, Xiphias gladius, which is easily distinguished from the istiophorids by its flat bill, the absence of jaw teeth and scales in adults, the short-based dorsal fin which is well separated from the second dorsal in adults, the absence of pelvic fins, and the presence of a single median keel on each side of the caudal peduncle.

Xiphias Linnaeus, 1758

XIPH Xiph

Genus : Xiphias Linnaeus, 1758, Systema naturae, ed.10:248.

Type Species : Xiphias gladius Linnaeus, 1975 by monotypy.

Synonymy : Ziphius Hector, 1875 (?misspelling); Ziphias Cheeseman, 1876 (?misspelling); Phaethonichthys Nichols, 1923 (based on incomplete juvenile specimen from stomach of a red-tailed tropic bird).

Remarks : This genus is monotypic.

Xiphias gladius Linnaeus, 1758

XIPH Xiph 1

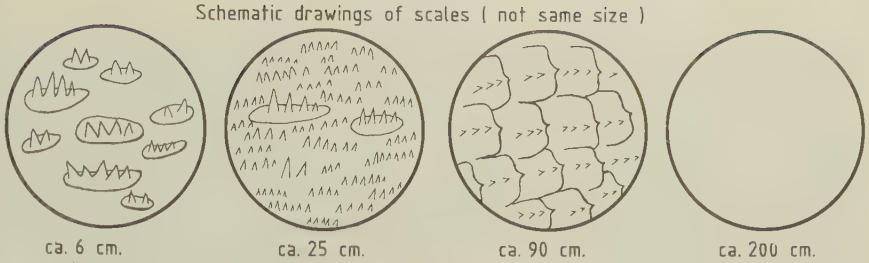
Xiphias Gladius Linnaeus, 1758, Syst.Nat., 10:248 (Habitat in Oceano Europae).

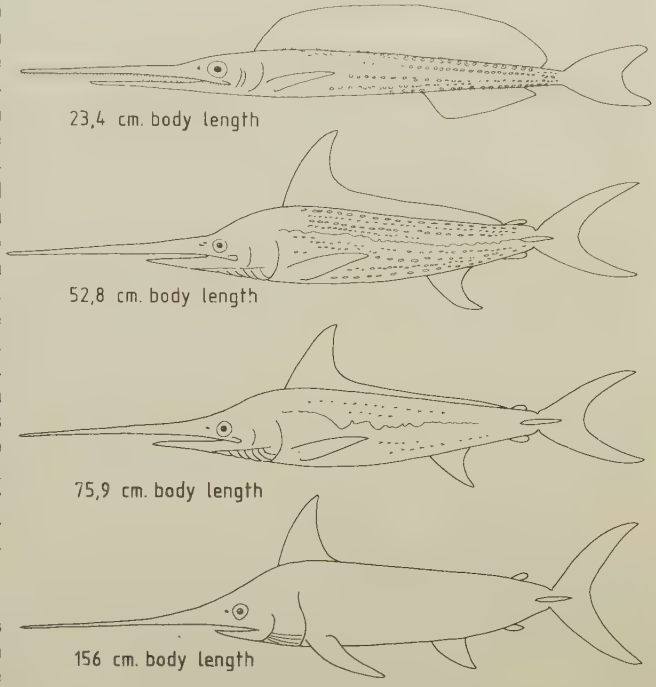
Synonymy : Xiphias gladius-Bloch, 1786; Xiphias imperator Bloch & Schneider, 1801; Xiphias rondeletti Leach, 1818; Phaethonichthys tuberculatus Nichols, 1923; Xiphias estara Phillips, 1932; Tetrapterus imperator-Rohl, 1942; Xiphias thermaicus Serbetis, 1951; Xiphias gladius estara-Whitley, 1964.

FAO Names : En - Swordfish; Fr - Espadon; Sp - Pez espada

Field Marks : Bill extremely long, its cross-section flat; no teeth in jaws, in adults a large single median caudal keel on each side; no pelvic fins; body without scales.

Diagnostic Features: Body elongate and cylindrical. Upper jaw prolonged into a long bill, flat-oval in cross-section (but both jaws prolonged into long bills in immature individuals); eyes large; mouth not protrusible; fine, file-like teeth present in specimens of about 1 m (body length), disappearing with growth; gill openings wide, gill membranes united only basally and free from isthmus; no gillrakers. Two widely separate dorsal fins in adults (continuous in immature specimens), the first much larger than the second; first dorsal with 34 to 49, second dorsal with 4 to 6 rays; two separate anal fins in adults (continuous in immature specimens) the first much larger than the second; first anal with 13 or 14, second anal with 3 or 4 rays; position of second anal fin slightly more forward than that of second dorsal fin; pectoral fins falcate, a little rigid and situated low on body sides, with 16 to 18 rays; pelvic fins and pelvic girdle absent; caudal fin large and lunate. Caudal peduncle with a large keel present on each side and a deep notch on both the dorsal and ventral surfaces; anus situated near first anal fin origin. Lateral line absent in adults, but recognizable in specimens to about 1 m body length as a wavy line, disappearing with growth. Adults scaleless but scales with small spines present in specimens to about 1 m body length. Vertebrae 26 (15 or 16 precaudal and 10 or 11 caudal). Colour: back and sides of body blackish-brown, gradually fading to light-brown on ventral side; fin membrane of first dorsal fin dark blackish-brown; other fins brown or blackish-brown.

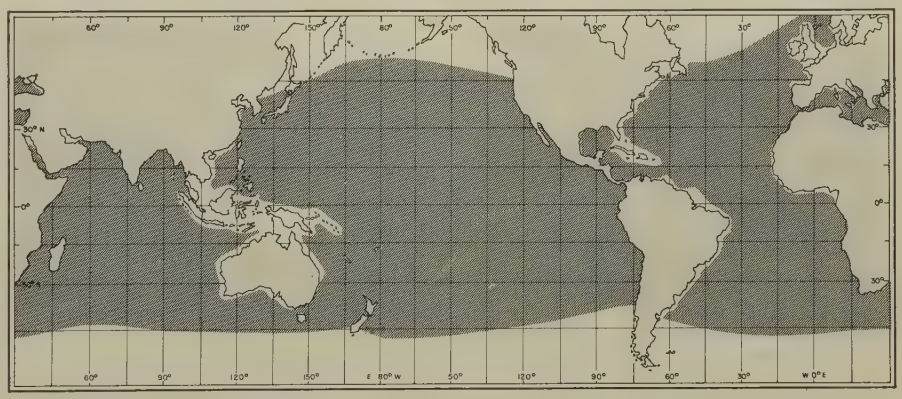

Schematic drawings of scales (not same size)
ca. 6 cm. body length
ca. 25 cm. body length
ca. 90 cm. body length
ca. 200 cm. body length (no scales)



Body changes of swordfish with growth (schematic)

In its preadult stage, the swordfish undergoes drastic morphological changes with growth, which affect the body shape, the bill and particularly the dorsal, anal and caudal fins.

Geographical Distribution: Cosmopolitan in tropical, temperate and sometimes cold waters of all oceans, including the Mediterranean Sea, the Sea of Marmara, the Black Sea, and the Sea of Azov. Based on data from commercial longliners' catches, the latitudinal range of this species extends from 50°N to 45°S in the western Pacific, from 50°N to 35°S in the eastern Pacific, from 25°N to 45°S in the Indian Ocean, from 50°N to 40°-45°S in the western Atlantic, and from 60°N to 45°-50°S in the eastern Atlantic.



Habitat and Biology: This is an epi-and mesopelagic, oceanic species, usually found in surface waters warmer than 13°C, the optimum temperature range being 18° to 22°C in the northwestern Pacific Ocean. The swordfish has the greatest temperature tolerance among billfishes, ranging from 5° to 27°C. Based on records of forage organisms taken by this species, its depth distribution in the northwestern Pacific ranges normally from the surface to about 550 m depth. It is believed, however, to descend occasionally into waters of 5° to 10°C and to depths of at least 650 m.

The swordfish is primarily a warm-water species and, generally speaking, its migrations consist of movements toward temperate or cold waters for feeding in summer and back to warm waters in autumn for spawning and overwintering. There are two hypotheses on the migration of the swordfish in the northwestern Atlantic: (1) they migrate to the north and east along the edge of the continental shelf during summer and return to the south and west in autumn, or (2) there are different groups of swordfish migrating from deep waters toward the continental shelf in summer and moving back to deep waters in autumn.

Larvae are more frequently encountered at temperatures above 24°C. In the Atlantic, spawning apparently occurs throughout the year in the Caribbean, the Gulf of Mexico, and in the waters off Florida, with the peak of the spawning season from April through September. In the Pacific Ocean, it occurs in spring and summer (March through July) in the central part, in spring (September to December) in the western South Pacific, and all the year round in equatorial Pacific waters. The best known spawning grounds of the swordfish are found in the Mediterranean Sea, off the southern part of the Italian Peninsula and Sicily, the main spawning concentrations occurring in the Straits of Messina. Adults are present on these spawning grounds in all months except January and February, and spawning is most intensive from the end of June to August, when males are often observed pursuing females. Eggs of this species have been found from June to September, and young swordfish up to 5 kg have been recorded from October to December. Large numbers of juveniles occur throughout the Mediterranean from November to March. Female gonads contain 2 to 5 million eggs. In the Atlantic Ocean swordfish spawn in the upperwater layer at depths between 0 and 75 m, at temperatures around 23°C, and salinity of 33.8 to 37.4°/oo.

Adult swordfish are opportunistic feeders, known to forage for their food from the surface to the bottom over a wide depth range. Over deep water, they feed primarily on pelagic fishes, including tunas (Thunnus), dolphinfishes (Coryphaena), Alepisaurus, Gempylus, flyingfishes (Exocoetidae), barracudas (Sphyraenidae) and others, and pelagic squids (Ommastrephes, Loligo, Illex and others), while in relatively shallow waters they take chiefly neritic pelagic fishes (mackerels, herrings, anchovies, sardines, sauries, needlefishes, etc.). Large adults often make feeding trips to the bottom where the temperatures may be 5° to 10°C and feed on demersal fishes (hakes, Bramidae, trichiurids, gempylids, redfish, lanternfishes (Myctophydae), Gonostomatidae, Sternoptychidae, etc.). Based on stomach contents from X. gladius, it is most likely true that the swordfish uses its sword to kill some of its prey, particularly squids and cuttlefishes, as is shown by the slashes on the bodies of prey found in swordfish stomachs.

Size : This species reaches a maximum size of 445 cm total length and about 540 kg weight. The size range of fish taken by the commercial swordfish longliners is 120 to 190 cm body length in the northwestern Pacific; the average weight in the Mediterranean Sea ranges from 115 to 160 kg. Usually females are larger than males, and most swordfish over 140 kg are females. Adults grow over 230 kg (rarely) in the Mediterranean, up to 320 kg in the western Atlantic, and up to 537 kg in the southeastern Pacific. The all-tackle-angling record for this species is a 536.15 kg (1182 lb) fish caught off Iquique, Chile in 1953.

There is little information on biological minimum size and age and some of the data are contradictory. X. gladius first spawns at 5 to 6 years of age and 150 to 170 cm eye-fork length (which is 85 to 88% of body length) in the Pacific and Indian oceans (Yabe et al., 1959). Males reach sexual maturity at a length of around 100 cm and females at a length of 70 cm in the Atlantic (Ovchinnikov, 1970). However, recent research conducted on swordfish off the southeast coast of the United States indicates that males mature at a smaller size than females (at about 21 kg for males and 74 kg for females) (E. Houde, pers.comm., cited from Palko, Beardsley & Richards, 1981). Kume and Joseph (1969) regarded swordfish of less than 130 cm eye-fork length as immature.

Interest to Fisheries : There are important fisheries for X. gladius in the Atlantic, Indian and Pacific oceans. Catches have been reported from 14 FAO Fishing Areas (21, 27, 31, 34, 41, 47, 51, 57, 61, 67, 70, 77, 81 and 87) by about 30 countries (major fishing nations: Japan, USA, Italy, Spain, Canada, Republic of Korea, China (Taiwan Province), the Philippines and Mexico) in the period from 1978 to 1982. The world catch was 40 279 t in 1978, 37 992 t in 1971, 36 402 t in 1980, 37 726 t in 1981 and 40 321 t in 1982. Only 1 439 t of the 1981 catches were taken in the Indian Ocean, while the rest were distributed in halves between the Pacific and Atlantic oceans (including the Mediterranean Sea), particularly in Fishing Area 61 (northwestern Pacific) with 8 085 t predominantly by Japan, and secondly by China (Taiwan Province), Fishing Area 37 (Mediterranean) with 6 584 t predominantly by Italy and Spain, and Fishing Area 77 (eastern central Pacific) with 5 210 t predominantly by Mexico and Japan. More than 2 000 t were reported in 1981 from 5 other Fishing Areas, i.e., Fishing Area 21 (northwestern Atlantic) with 2 315 t predominantaly by USA, Fishing Area 27 (northeastern Atlantic) with 2 163 t predominantly by Spain, Fishing Area 31 (western central Atlantic) with 2 548 t predominantly by USA, Fishing Area 34 (eastern central Atlantic) with 2 117 t by some 10 countries, and Fishing Area 71 (western central Pacific) with 2 940 t predominantly by the Philippines (FAO, 1983). Of the 1982 world catch (40 321 t), only 3.7% (1 500 t) were taken in the Indian Ocean, 43.9% (17 705 t) in the Pacific Ocean, and 52.4% (21 116 t) in the Atlantic Ocean including the Mediterranean Sea (FAO, 1984).

Catch records from the high seas tuna longline fishery indicate that swordfish are taken almost throughout the range of that fishery. For the most part, however, swordfish catches are incidental to the tuna longline fishery, except for the Japanese swordfish longlines (nocturnal longlines) called in Japanese "Mekanawa" (=swordfish longline) or "Yonawa" (=night longline) which operate in the northwestern Pacific, from Japan eastward almost to 140°W. Other important commercial fisheries directed at the swordfish are located in the western North Atlantic from the Grand and Georges Banks to the Gulf of Mexico (harpooning and longlining), in the eastern Atlantic, especially in the Gulf of Guinea and the Mediterranean Sea (longlining, harpooning and various kinds of trapping or setnetting), and in the South Atlantic off the coasts of Brazil and Uruguay (longlining).

Major sportsfishing areas for trolling and drifting baited lines are located off the east coast of the USA from New York to Texas, from off the coast of California to Ecuador, Peru and northern Chile, off the east coast of Australia and around New Zealand.

The quality of the flesh is excellent for steaks, canning or "Teriyaki" (grilled meat with sugar; soy-sauce and rice wine in the Japanese way). Marketed mostly fresh or frozen.

Local Names : ALGERIA: Pez espada; ARGENTINA: Pez espada; AUSTRALIA: Broadbill swordfish, Swordfish; BRAZIL: Espadarte, Peixe espada; BELGIUM: Espadon; CANADA: Broadbill swordfish, Espadon, Swordfish; CHILE: Albacora, Pez espada; CHINA: Chien-chi-yu, Ki-hi-khu, Tinmankhu; CUBA: Pez espada; DENMARK: Svaerdfisk; FRANCE: Espadon; GERMANY (FED.REP.): Schwertfisch; GREECE: Xiphias; INDIA: Kuthira-meen (Lacadive Archipelago?), Mas-hibaru; IRELAND: Luinniasc; ITALY: Pesce spada; JAPAN: Andaachi, Dakuda, Ginzasu, Goto, Hirakucha, Hyu, Io, Izasu, Kudamaki, Medara, Meka, Mekajiki, Mesara, Okizaara, Rakuda, Shiutome, Shutome, Suzu, Teppo, Tsun; MALTA: Piscispat, Pixxi spad; MEXICO: Pez espada; NETHERLANDS: Zwaardvisch; NEW ZEALAND: Broadbill; NORWAY: Sverdfisk; PERU: Pez espada; PHILIPPINES: Dugso, Doguso, Lumod, Malasagi, Malasugi, Manumbuk, Mayaspus; PORTUGAL: Agulha, Agulhao, Espada, Espadarte, Peixe agulha, Peixe espada; REPUBLIC OF KOREA: Whang-Sae-chi; ROMANIA: Reste cuspada; SOUTH AFRICA: Broadbill, Swaardvis, Swordfish; SPAIN: Aja para, Chichi spada, Emperador, Espada, Espardarte, Pez espada; SRI LANKA: Kadu kpooara; SWEDEN: Swardfisk; TUNISIA: Bou sif; UNITED KINGDOM: Swordfish; USA: Broadbill, Broadbill swordfish, Swordfish; USSR: Mechenos, Mech-ryba, Meshvenosouiye; VENEZUELA: Pez espada; VIET NAM: Ho cá mui kiem; YUGOSLAVIA: Babljan, Iglun, Igo, Jaglun, Macokljun, Sablijck.

Literature : Nakamura et al., 1951; Yabe et al., 1959; Tibbo, Day and Doucet (1961); Ovchinnikov, 1970; Palko, Beardsley and Richards (1981); Nakamura, 1983.

Remarks : The local name "Albacore" is used for Xiphias gladius in Chile, while "albacore" is commonly used for the longfin tuna, Thunnus alalunga in many English speaking countries. In the French speaking countries, the yellowfin tuna, Thunnus albacares is called "Albacore".

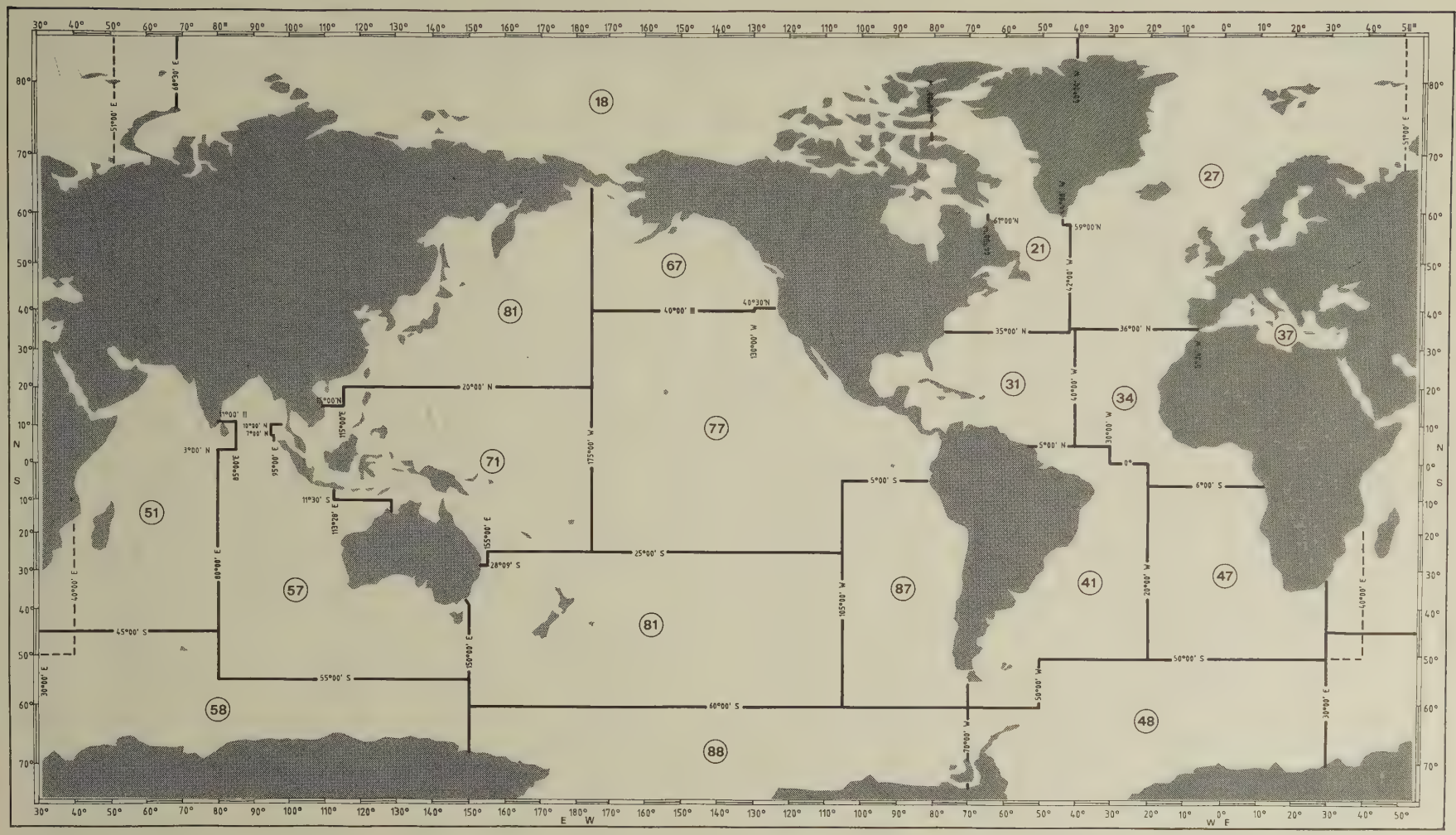
3. LIST OF SPECIES BY MAJOR FISHING AREAS

SPECIES	PAGE	GEOGRAPHICAL DISTRIBUTION — MAJOR MARINE FISHING AREAS FOR STATISTICAL PURPOSES																		
		18	21	27	31	34	37	41	47	48	51	57	58	61	67	71	77	81	87	88
Istiophorus albicans	21		●	●	●	●	●	●	●											
Istiophorus platypterus	23						○		○		●	●		●		●	●	●	●	
Makaira indica	27					○			○		●	●		●		●	●	●	●	
Makaira mazara	30								○		●	●		●		●	●	●	●	
Makaira nigricans	33		●	●	●	●		●	●											
Tetrapturus albidus	35		●	●	●	●	○	●	●											
Tetrapturus angustirostris	38								○		●	●		●		●	●	●	●	
Tetrapturus audax	40								○		●	●		●		●	●	●	●	
Tetrapturus belone	43						●													
Tetrapturus georgei	45			●		●	●													
Tetrapturus pfluegeri	46		●	●	●	●		●	●											
Xiphias gladius	48		●	●	●	●	●	●	●		●	●		●	●	●	●	●	●	

● areas of residence

○ areas of invasion (occasional presence)

MAJOR MARINE FISHING AREAS FOR STATISTICAL PURPOSES



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5. INDEX OF SCIENTIFIC AND VERNACULAR NAMES

EXPLANATION OF THE SYSTEM

The index applies exclusively to family and species accounts under Section 2 (Systematic Catalogue)

Type faces used:

Italics : Valid scientific names (genera and species)

: Synonyms (preceded by an asterisk)

ROMAN (caps) : Family Names

Roman : International (FAO) species names

: Local names (preceded by an asterisk)

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